PESTICIDE IMPACT ASSESSMENT

PRONAMIDE (KERB ^{R})

USDA/STATE ASSESSMENT TEAM

ON PRONAMIDE

Coordinated by the Office of Environmental

Quality Activities, USDA

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Chapter 1

SUMMARY

Pronamide is a relatively new herbicide having been introduced in October, 1972. The uses of this herbicide are increasing both in acreage in the uses for which it is registered and in promising new uses that are being developed. The registered uses so far are specialized on "minor use" crops which represent a significant area of needed pest control.

Lettuce Production:

Of the 150,000 acres of lettuce grown in California, about 80,000 acres receive pronamide. Pronamide is the most effective and safest herbicide for control of weeds in lettuce crops that are sown in the fall, winter, and early spring. Loss of this herbicide for use in lettuce would have very serious impacts on production. Other herbicides often used in conjunction with pronamide to broaden the spectrum of weed control in lettuce give only limited help when used alone. Fifteen to 20 years ago, the lettuce grower could depend for the most part on adequate, inexpensive labor. With the current field labor and todays labor policies, highlighted by the outlawing of the short-handled hoe, the lettuce grower has no choice, he must depend on chemical energy to produce lettuce of the quality and quantity the consumer has learned to expect. Costs of the possible loss of pronamide in growing lettuce are shown in "Economic Information" section of the report.

Alfalfa and Other Small Seeded Legumes:

Hay - In Western irrigated areas weeds may or may not depress the total yields of hay (alfalfa plus weeds) but they reduce its feed value. The principal use of pronamide in western forage alfalfa is to contro

downy brome, quackgrass, perennial ryegrass, annual bluegrass, and certain other broadleaf and grassy weeds. Forage quality is increased an average of 10%. Other herbicides will control downy brome in established stands but only pronamide and propham can be safely used for control of downy brome following a fall seeding. Other weed control practices such as cultivation, hand labor, and mowing are not practically effective.

In the upper Northcentral and Northeastern States, quackgrass is almost universally present in forage legumes. Pronamide is the most effective herbicide for control of quackgrass and other perennial grasses in these alfalfa stands. By eliminating the competitive weedy grasses from the stand of legume, quality is greatly increased, longevity of stand is increased 25% and the reduction in infestation of quackgrass benefits the crops grown in rotation.

Simazine and terbacil are moderately effective for control of grasses in established stands of alfalfa but can not be used during the year of establishment. The potential benefits of using pronamide to control quackgrass in alfalfa and birdsfoot trefoil far exceed the benefits realized to date. The practice of using pronamide is expanding as producers recognize the benefits obtained.

Seed Production - In alfalfa, weeds must be controlled to eliminate yield losses from weed competition, to reduce losses during harvest and cleaning of seed because of the presence of weed material, and to increase the value of the product if it is free of weed seeds. Pronamide controls annual weed grasses such as downy bromegrass and is the only herbicide available that is adequate and safe for control of perennial grasses such as quackgrass. It also controls the parasitic noxious weed, dodder. It increases alfalfa seed production 30% and seed

quality 5%. The longevity of stand is increased 20%. Several alternative herbicides are effective for weed control in alfalfa seed production, however, pronamide is especially safe in alfalfa and controls certain major weeds, including dodder, selectively.

Clover seed production in Oregon is a highly specialized enterprise in an area where weed problems abound. Oregon growers supply clover seed effectively and economically for much of the area of the United States where clover is used for forage. Control of weeds increases yield of seed 100% and quality of seed (value) 10%. Pronamide is the only available herbicide for selective control of perennial grasses. It also controls annual grasses. Pronamide is tolerated by clover seedlings in the trifoliate stage of growth, therefore it can be used during establishment as well as in established stands. None of the alternative herbicides are as versatile or as generally effective. Pronamide is a vital production tool in the production of clover seed.

Blueberries and Caneberries

Excellent weed control is essential in mechanically harvested blueberries and caneberries. Pronamide is widely used because it is the most effective herbicide for control of quackgrass that commonly infests caneberry plantings. These plantings usually persist up to 15 years. It is estimated that 35 percent of the acreage is treated with pronamide in the Northwest. Cultivation is not an adequate alternative because the hedge-like plantings, and trellising in many cases, will not allow cross cultivation. Also, excessive moisture at critical times precludes cultivation. It is estimated that the cultivation alternative would require

three hand weedings. In addition to the high direct cost, hand weeding would damage canes and reduce the next year's crop yields by 10 percent. Continued use of pronamide is necessary to maintain adequate acreage to supply the demands for high quality fruit.

Woody Ornamentals and Christmas Tree Production

Woody ornamentals, represented by a wide range of species, have weeds controlled by a number of different herbicides and other methods of weed control. Pronamide provides a high degree of selectivity for many species of woody ornamentals and is especially useful where the weed problems are grasses such as quackgrass, other perennial grasses, and downy bromegrass. Dichlobenil and simazine are somewhat effective on these; however, pronamide is a superior treatment for these special weed problems for which there is no practical alternative. If pronamide were not available for these uses, production would be curtailed or restricted to those areas where quackgrass is not present.

Pronamide in Turf

Pronamide is widely used and is a growing practice in the Southern states where golf courses and other athletic fields are almost exclusively bermudagrass. It is the only herbicide effective both as preemergence and postemergence treatments for annual bluegrass control in bermudagrass. It is the only herbicide registered for annual bluegrass control in bermudagrass golf greens. Other herbicides, such as DCPA (Dacthal) and bensulide are effective for annual bluegrass control in bermudagrass fairways if applied just before annual bluegrass

germinates but, because of uncertainties about its time of germination in any given year, the failure rate may be 30 to 40%. This rate of failure is unacceptable on highly maintained golf courses. If annual bluegrass is not controlled, it continues growth until early summer and suppresses growth of bermudagrass. When the annual bluegrass dies because of heat or drought, it leaves essentially no green cover for three or four weeks while bermudagrass is making adequate recovery growth to provide grass cover.

Economic Information

Short-run economic analyses of losses to agriculture of prohibiting the use of pronamide were completed for lettuce and alfalfa only. These are the two larger uses of pronamide. The analyses assumed competitive market pricing, resource mobility, and no externalities. Limitations of the study are discussed.

It was estimated that prohibiting use of pronamide in alfalfa would result in a total net loss to alfalfa growers of $1.4 million with use of alternative herbicides. If no alternative herbicides were available, the loss would be $4.3 million.

Economic analysis of the impact of prohibiting use of pronamide on lettuce was based mostly upon production in the Salinas Valley and the Imperial and Blythe areas of California. Estimates indicated yields would decrease 10%, as much as 20% of the crop would be graded a lower quality, and weed control costs would increase $25 to $40 per harvested acre. Revenue losses alone from yield and quality reductions would amount to $264 to $396 per acre per year in the Salinas Valley or a total loss of $19 million to $28 million assuming no price changes or acreage shifts. Similar losses in the Imperial and Blythe areas would be $212 to $321 per acre with a loss to growers ranging from $6 to $9

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[illegible] of the impact of prohibiting use of 2,4-D on potatoes based mostly upon production in the Salinas Valley and the Imperial areas of California. Estimates indicated yields would decrease 10% and the crop would be graded a lower quality, and weed control [illegible] $25 to $40 per harvested acre. Revenue losses alone from quality reductions would amount to $164 to $306 per acre per year in the total loss of $19 million to $23 million assuming no price shifts. Similar losses [illegible] in Texas and Arizona are [illegible] per acre with a loss to growers ranging from $6 to

million. Total losses in these areas range from \$25 to \$37 million.

If there were a price rise of 12%, it would cost lettuce consumers a total of about \$50 million annually. On the other hand, those lettuce growers who previously had not used pronamide would benefit from increased returns. Given the small acreage involved and, thus, the significance of the loss per acre if pronamide is banned, it is clear that shifts in acreage and/or price will occur. Too few agricultural economists, however, have given lettuce sufficient emphasis to predict the consequences of such shifts. The total losses to the growers and the consumers could be as much as \$87 million.

Health and Environmental Information

Pronamide's general toxicological properties to animals, birds, and fish include a relatively low order of toxicity. In one chronic feeding study, an excess number of tumors were produced by male mice but not the female. Some toxicologists believe these data show that pronamide is a carcinogen, others do not.

The most likely human exposure to pronamide would be by eating lettuce grown where pronamide is used extensively in this crop. Lettuce samples taken in 1977 in the Salinas Valley area of California averaged less than 0.01 ppm pronamide residue. There have been no measurable residues detected in blackberries, blueberries, boysenberries, and raspberries from plants that have been treated during the fall and winter with pronamide.

Established tolerance on alfalfa is 10 ppm. Alfalfa hay from alfalfa that had been treated with pronamide during the fall and winter had

residues less than 5 ppm. Alfalfa is not ingested directly by man. It is fed to dairy and meat animals and chickens. The residue tolerances set for eggs, meat, milk, and related products is 0.02 ppm (0.2 ppm for kidney and liver). In a market-basket survey by Rohm and Haas Company, in areas of greatest pronamide usage, no detectable residues were found in milk.

Pronamide's use in non-food crops of turf, ornamental, and Christmas trees presents very low exposure and risk to humans.

In the environmental consideration of pronamide uses, there are minimal risks to vegetation in adjoining areas. Any pronamide carried in runnoff water would be largely that adsorbed on soil and organic particles of the soil. It is low in water solubility. It presents low hazard to fish, birds, and wildlife because of their low exposure to pronamide and because of the low toxicity to animals and birds and the moderately low toxicity to fish.

Chapter 2

INTRODUCTION

Use of pronamide (3,5-dichloro-N-(1,1-dimethyl-2-propynyl) benzamide) can be properly classified as "minor use" as the term is currently defined. Pronamide is a selective herbicide used preemergence to control many broadleaf and weed grasses in lettuce. It is especially important in California and the Southwest. It controls quackgrass, other perennial grasses, downy brome, many other annual grasses, chickweed, henbit, speedwells and some cresses in alfalfa, clover, birdsfoot trefoil, and crownvetch. It is especially important for control of such weeds in blueberries, raspberries, and blackberries that are to be mechanically harvested in the Northwest. It is important for control of weeds in Christmas tree and woody ornamental plantings, and it is the only herbicide registered and effective as both pre-emergence and postemergence treatments for control of annual bluegrass in bermudagrass turf in the Southern U. S.

The amount of pronamide used is increasing each year for the specific "minor use" crops for which it is registered. Because of the recency of its introduction (1972) pronamide has not reached its full potential. Scientists are still finding promising uses for which it is not yet registered. Also, many farmers are just now discovering the advantages of its use.

On May 9, 1977, the Environmental Protection Agency (EPA) issued a notice of presumption against registration of pesticide

products containing pronamide and indicated that a 45-day period was allowed to submit rebuttal evidence. A request for an additional 60 days in which to present evidence was granted. Therefore, rebuttal evidence should be submitted by August 29, 1977. In the May 9, 1977 notice, EPA cites as the reason for the "rebuttable presumption" that pronamide induced oncogenic effects on experimental mammalian species or in man as a result of oral, inhalation or dermal exposure. Based on criteria set forth in the Agency's Interim Procedures and Guidelines for Health Risk and Economic Impact Assessment of Suspected Carcinogens (May 25, 1976; 41 F.R. 21402) EPA concluded that the risk index has been exceeded by all registrations and applications for registration of pesticide products containing pronamide, and that a rebuttable presumption against new or continued registration of such products has therefore arisen.

Pronamide is an excellent herbicide capable of selectively controlling a large number of germinating weed species, including most of the winter annual broadleaf weeds in lettuce and other winter grown crops such as seed alfalfa crops in California, clover in Washington and Oregon, brambles in several states, etc. It is unsurpassed for the control of winter weeds in fall and early spring grown lettuce in California. It is particularly effective in the winter lettuce of the Imperial and Blythe areas and through most of the growing seasons for the Coastal growing areas of Salinas, Santa Maria, and Oxnard. Pronamide controls weeds in the cabbage family; it is also very effective on volunteer grains, several summer broadleaf weeds, and a number of grasses.

It is one of the most effective materials yet found for the control of quackgrass, a particularly serious problem in the perennial crops of northwestern and northeastern states. In alfalfa it is the only herbicide which will effectively control quackgrass.

Commerically, the major drawback of pronamide is that it is currently registered only on comparatively small acreage crops such as lettuce, alfalfa grown for seed, caneberries, and a few other crops. It is not used in major crops such as corn, soybeans, small grain, and cotton because it is not selective on these. If pronamide were discovered today, it might not be developed because of the present cost of registration. In recent years, with this cost of registration, most chemical companies concentrate their development efforts for herbicides on the big acreage crops mentioned above.

The purpose of this Pesticide Impact Assessment is to present benefits/exposure information regarding pronamide. The scope of the report includes some aspects of five crop-groups that use pronamide, i. e., (1) lettuce, (2) alfalfa and other small seeded legumes, (3) berries, (4) woody ornamentals and Christmas trees, and (5) turf.

Information collection and evaluation, including economic analysis, was done by the State-Federal Assessment Team. Information came from many sources including: Agricultural statistics 1976 (USDA); survey information furnished by agricultural extension agents, farmers, and research scientists; research publications; the Horticultural Research Institute, Inc.; Oregon Crop and Livestock Reporting Service; and the Rohm and Haas Company. Economic analysis was done only on lettuce and alfalfa. The lack of full documentation for some uses should not be interpreted as reflecting low priorities to

agriculture. Rather it reflects on the lack of detailed data on some of the newer and still developing uses, and on currently incomplete surveys of existing information in some other cases. Nevertheless, we believe the information presented is indicative of the unique importance of pronamide in crop "minor uses" for which it is registered.

Chapter 3

BIOLOGICAL INFORMATION

A Statement of Uses and Benefits, June - July, 1977

3.1 LETTUCE PRODUCTION:

3.2 ALFALFA AND OTHER SMALL SEEDED LEGUMES:

3.3 PRODUCTION OF BLUEBERRIES AND CANEBERRIES:

3.4 WOODY ORNAMENTALS AND CHRISTMAS TREE PRODUCTION:

3.5 TURF:

3.1 Lettuce Production

3.1 Pronamide - An Important Herbicide for California Lettuce.

For most of the year the quality of lettuce is good and the availability is constant.

The producer of lettuce faces many expenses, not the least of which is for weed control. He often must pay $100.00/A for hand hoeing. Fifteen to 20 years ago, there were few herbicides available to reduce this weed bill. He depended for the most part on adequate inexpensive labor. With current field labor and today's labor policies, highlighted by the outlawing of the short handled hoe, a lettuce grower has no choice, he must depend heavily on chemical energy to produce lettuce of the quality and quantity the housewife has learned to expect in the supermarket. Lettuce prices will increase if pronamide is not available for control of the important weeds that infest this crop. Loss of pronamide may eliminate the lettuce from supermarkets for part of the year or at best, greatly increase the price.

There are a number of other herbicides besides pronamide also registered for use in lettuce. Benefin (Balan) is particularly effective for the control of summer weeds with the exception of those in the lettuce family, the tomato family, and several other important broadleaf species, however, benefin is very good on the summer grasses. If we were to rely entirely on benefin and were unable to obtain pronamide, it would cost the lettuce growers in California and ultimately the consumers millions of dollars annually. Of the 150,000 acres of lettuce grown, in California about 80,000 acres receive pronamide. Many of these acres receive benefin as well. Since 80,000 acres need pronamide, we would have to assume a loss in production or a significant increase in the cost of lettuce due to the

cost of controlling those weeds with hand labor which only pronamide controls. If we go one step further and assume that we might possibly lose both pronmaide and benefin, there are still other herbicides which have been used in the past which could be considered. The most promising of this group is bensulide. Bensulide is an acceptable lettuce herbicide in some areas. It is nonphytotoxic to the crop at registered application rates, but is very selective and controls only a narrow range of weed species, primarily barnyardgrass, pigweed, and lambsquarter, and to some extent, purslane. Since there are 25 to 30 important weeds in lettuce, see Appendix, Tables 6, 7, and 8, it is questionable how much bensulide would help California growers outside of the summer grown lettuce in the Salinas and Contra Costa areas. The winter grown lettuce producers would probably not use this herbicide and would have to rely on less effective and more expensive long handled hoe labor. Having only bensulide (Prefar), we could expect to lose essentially 40,000 acres of lettuce production.

The other herbicides with some use in combination with benefin, that are registered for lettuce, propham (ChemHoe) and CDEC (Vegadex), have specific uses and are only beneficial when used in combination with benefin and pronamide. They give only very limited help when used alone.

3.1.1 LETTUCE - CENTRAL COAST, CALIFORNIA[1/]

1.	Planted acres - 1977 ave.	65,045 Acres
2.	Yield per acre - 1977 ave. 634 Cartons/Acre	32,968 Lbs.
3.	Acres treated with herbicides: 1977 - ave. 65,000	100%
	a. Preferred herbicide	Pronamide
	b. Preferred herbicide mixed with other herbicides (Benefin)	10%
	c. Other herbicides	Benefin

Pronamide is used on approximately 100% of the 65,000 acres of lettuce grown in the Salinas Valley. The principal reason for its extensive use is its excellent control of the crucifer-type weeds such as shepherd's purse, mustard, and london rocket. Other difficult to control weeds that are controlled by pronamide include Solanum species, such as hairy nightshade and volunteer grains such as barley.

During the summer applications of herbicides to lettuce, pronamide is frequently used as a sequential treatment with benefin, or is sometimes used as a tank mixture in this combination. The advantages of this tank mix are principally to control pigweed and lambsquarters.

4. Alternative herbicides to first preference (do not consider other related herbicides). Specify and give application per acre.

1/ Information from Surveys provided by the Agricultural Extension Staff in California.

a.	Propham	4 Lbs/Acre active
b.	CDEC	4 Lbs/Acre active
c.	Bensulide	6 Lbs/Acre active

Alternate herbicides that might be used in the absence of pronamide would include benefin. Benefin is a soil-incorporated herbicide which makes it difficult to apply during inclement weather, which of course occurs during the winter planting months of December, January, February, and oftentimes early March. The additional expense of soil incorporation must be added to weed control cost which is considerable when compared to the ease of application of a postplant, surface-applied pre-emergence treatment of pronamide.

Propham, another registered herbicide for lettuce, is extremely limited as it controls only one or two weed species. It also possesses a narrow range of crop tolerance.

CDEC, a herbicide that may be used either pre-emergence or preplant incorporated treatment, has some value in combinations with pronamide or in combinations with benefin, but its spectrum of weed control is limited when used by itself.

Bensulide is not used at all in the Salinas Valley principally because of its weakness in controlling broadleaf weeds and its long term persistence in the soil which restricts crops in rotation.

5. Yield difference: Preferred herbicide vs.

   a. Other related herbicides. Benefin = reduced weed control. — 20% Yield Reduction

   b. Other herbicides: specify

      1. Propham - crop suppression — 20% Yield Reduction

      2. CDEC - crop suppression — 20% Yield Reduction

      3. Bensulide - ineffective weed control — 30% Yield Reduction

   c. Cultivation and hand hoeing - Comments — 35% Yield Reduction

   d. Cultural practices

      1. Change planting date. — Not possible - lettuce planted 9 months of the year.

      2. Rotations. — Crop rotations are used with crucifer crops.

Benefin may often cause a 20% yield reduction to lettuce when used during the winter period of planting because of its limitation on crucifer-type weeds. Other herbicides in Question 5-B will also produce crop suppressions which will reduce head size and may often reduce uniformity because of delay of the maturity of some of the lettuce.

CDEC also may cause a delay maturity of some of the lettuce which results in lack of uniformity at harvest especially when used at rates of five to six pounds per acre which are often necessary to control broadleaf weeds.

Bensulide is basically an ineffective broadleaf herbicide and is not economically feasible in the Salinas Valley. Also, long residual activity in soil may present problems to succeeding crops.

Cultivation only and hand hoeing. When weeds are not removed in the early period of development of the lettuce plant, 30 to 35% yield reductions may occur as well as a reduction in head size. Early weed competition with the normal development of head lettuce tends to force a spiral or pointed type head which is oftentimes not marketable. Although weeding and thinning are standard practices in the presence of herbicides, if the grower was left mechanical means only, this would greatly restrict the acreage on which lettuce could be grown on in the Salinas Valley. Where pronamide is band treated over the row, cost of cultivations that are used is less because the tractor driver can drive faster since the cultivator blades do not have to be set so close to the row of lettuce plants.

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Any changes in planting dates would not be possible as lettuce is grown during the nine months of the year commencing from December through September. Actually lettuce is in the ground for eleven months during the year, but is either being sown or harvested from December to October in a given crop year.

Crop rotations already are extensively used with other crucifer crops as a means of reducing overall weed control costs. The high value of Salinas Valley land, ranging from $275 to $450 per acre cash rent per year, makes it essentail to grow crops with the greatest potential returns. The 65,000 acres of lettuce are often double-cropped and are grown in rotation with crucifer crops and to some degree celery.

6. Change in commodity quality
   a. Dockage percentage — None
   b. Cleaning costs, per unit — None
   c. Lower grade. Reduction in yield and head size. — 20%

Weeds basically and the competition from weeds, especially when not removed at the early three to four true leaf stage, will often cause a reduction of yield and head size as well as delayed maturity. This has

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been estimated to be in the neighborhood of 20% where weeds are left until the lettuce is in the six-leaf stage of development.

7. Percent of acres treated with alternative that may not receive sufficient rainfall to activate the material 10-14 days after application. — Alternative herbicide mus be soil incorporated. Increase cost of $20/Acre

Alternate herbicides such as benefin must be soil incorporated at the time of application. This is because of the volatility of benefin. This incorporation practice increases the cost of the herbicide an additional $20/Acre. Since most of the lettuce is grown under irrigation, it is essential that all plantings receive either sprinkler or furrow irrigation following a herbicide and planting sequence.

8. Percent of acres treated with alternative herbicides that may not receive first cultivation at the optimal time, about 21 days after emergence. — 25% of Acreage

Approximately 25% of the lettuce acreage is planted during winter months which would make it difficult to cultivate because of the frequent rains that follow the germination of the crop. It is during this period

of planting that a herbicide such as pronamide is of great value to the Salinas Valley lettuce grower. This is important because it limits the amount of cultivation that may be done during this period of time, the inclement weather limits field workers from hand weeding the crop, and, thirdly, this type of condition limits the use of soil incorporation equipment which is essential for the application of other herbicides such as benefin.

9. Increase in number of cultivations if alternative herbicides are used. — 2 additional cultivatio[ns], 1 extra hoeing

Increase of number of cultivations with the use of benefin is estimated to be at least two extra cultivations and one extra hand hoeing. This is principally because of the weakness of benefin on the crucifer weeds and the nightshade species. See appendix Tables 6, 7, 8, 9, and 10.

10. Increase in number of cultivations if no alternative herbicide is used. — 4-5 additional cultivations, 2-3 hoeings

If no alternate herbicide is used, four to five additional cultivations and at least two to three hoeings will be needed in order to maintain weed free conditions for optimum lettuce production.

11. Hand labor if applicable.

a. Number of acres — Approximately 15,000 acres winter planted.

Labor supply during this period inadequate.

b. Cost per acre per season — Winter weeding cost = $75-$100/Acre

Hand labor, if required, on approximately 15,000 acres of winter-seeded lettuce would cause a serious curtailment of lettuce production during this period of time. This comment is made on the basis of a low labor population in the Salinas Valley during the winter months, principally because of the reduction in field operations. At this time growers are highly dependent upon pre-emergence herbicides such as pronamide.

The increased cost of weeding these plantings is estimated at $75 to $100 per acre without the use of the preferred herbicide pronamide.

12. Shifts to other crops: specify percent of preferred herbicide treated acres

a. Not possible Salinas Valley cool temperatures

b. Limit cropping sequence other than cool season vegetables

c. $275-450 land rental

The shift to other crops is not at all possible for the Salinas Valley. The extensive development of this area as a production center for vegetables, principally, cool season vegetables, limits its diversity to other types of cropping patterns. Consequently, vegetables such as lettuce, crucifers, and celery are the principal vegetables that comprise the economy of this district. Some $142 million are derived from lettuce production per year in the Salinas Valley. The loss of this crop or reduction of this crop would greatly affect the overall economy. It would be a primary loss in other related jobs of the satellite industries.

13. Price of herbicide materials: per gal, lb. etc.

a. Preferred herbicide Kerb (pronamide) $8.50/Lb

b. Alternatives

1. Balan (benefin) $11.10/Gal

2. ChemHoe (propham) $9.50/Gal

3. Vegadex (CDEC) $16.25/Gal

The prices of several herbicides are listed. These prices reflect current day quotations. The current price structures of the four leading lettuce herbicides

are fairly competitive, but the loss of pronamide would greatly increase the cost of weed control because of the lesser effectiveness of the three alternative products.

6. Change in lettuce quality due to not having a head formed.

   a. Percentage unmarketable heads (due to hand hoeing and wind) — 15%

   b. Increase costs for weed-insect problem — 1 extra insecticide application @$13.00

7. Percent of acres treated with alternative herbicides that may not receive first cultivation at the optimal time, about 21 days after planting — 25%

8. Increase in number of cultivations if 1st alternative herbicide is used. Balan 1 cult. + 1 hand hoeing — As much as $100/A

9. Increase in number of cultivations if 2nd alternative herbicide is used. Propham 1 cult. + 1 hand hoeing — As much as $120/A

10. Increase in number of cultivations if 3rd alternative herbicide is used. Prefar 1 cult. + 2 hand hoeing — not used for most planting

11. Increase in number of cultivations if no alternative herbicide is used. — 3 cultivations + 2 hand hoe

12. Hand labor if applicable

    a. Number of acres — 85% 25-50% thinning and some hand weedin

    b. Cost per acre per season — $100-200

3.1.2 Lettuce - Imperial and Blythe, California[1/]

1.	Planted acres - 1976 - 1977 ave.	53,500
2.	Yield per acre - 1976 - 1977 ave.	450 cartons/A
3.	Acres treated with herbicides: 1976 - 1977 ave.	100%
	a. Principle herbicide alone	benefin
	b. Principle herbicide mixed with other herbicides	propham
	c. Other herbicides	pronamide
4.	Alternative to the pronamide (do not consider other related herbicides). Specify and give application per acre.	
	a. Bensulide (Prefar*)	4-6 pounds ai
	b. Propham (Chemhoe*)	4 pounds ai
	c. Benefin (Balan*)	1 1/2 pounds ai
	* Tradename	
5.	Yield difference: pronamide herbicide vs.	
	a. First alternative benefin	-10%
	b. 2nd alternative propham	-15%
	c. 3rd alternative bensulide	-20%
	d. 4th alternative	
	e. No herbicide	-75%
	f. Cultivate and hand hoeing	-15%
	g. Cultivation only	-10-66%
	h. Hand hoeing only	-15%
	i. Cultural practices	
	1. Change planting date	No change
	2. Rotations	No small grains, milo is OK

1/ Information from Survey provided by Agricultural Extension Staff in California

3.2 Alfalfa and Other Small Seeded Legumes

3.2.1 Pronamide for Weed Control in Alfalfa Grown for Hay in the Irrigated Areas of the Western United States.

I. Acreage. 4,500,000 acres.

II. Yield of hay. 5.0 tons/acre per year.

III. Value of hay. $65/ton or $325/acre per year.

IV. Weed problems. Alfalfa thrives under conditions of western irrigated agriculture and competes well with weeds. When established as a perennial, it suppresses many weeds that are troublesome in other crops. Nevertheless, there are certain serious weed problems in the production of alfalfa hay. Because alfalfa seedlings grow slowly, weeds are troublesome during the year of establishment. During the period of winter dormancy, winter annual weeds such as downy brome and several species of mustard become established. These weeds grow profusely in the early spring and may be very troublesome in the first cutting of alfalfa. In many areas, alfalfa suppresses most summer annual weeds. However, in the warmer areas where five or more cuttings of hay are produced each year, certain rapid-growing summer annuals become established in one cutting and survive to become a problem in a subsequent cutting. Weeds may or may not depress the total yield of hay (alfalfa plus weeds), but they reduce its feed value. Furthermore, some weeds such as downy brome produce harsh awns, which damage the mouth, eyes, and nose of livestock. In some western areas, perennial grasses such as quackgrass and perennial ryegrass may be troublesome in alfalfa. The parasitic weed dodder is troublesome in alfalfa grown for hay in the warmer areas of the region.

13. Shifts to other crops: specify percent of principle herbicide treated acres

    a. sugar beets, alfalfa, cereals, cotton ____________

14. Price of herbicide materials: per gal, lb., etc.

    a. Principle herbicide Pronamide — $17/lb

    b. Alternatives

        1. Balan (benefin) — $11.00/gal

        2. Prefar (bensulide) — $4.45/lb ai

        3. Chemhoe (propham) — $9.50/gal (2 EC)

V. Herbicides for weed control in alfalfa.

A. When herbicides are used:

1. During establishment: Certain herbicides are used to control weeds during establishment. These may be applied pre-planting or preemergence or postemergence.

2. In established stands: For control of winter annual weeds, herbicides may be applied to the soil in the fall or early winter, or foliar active herbicides may be applied from early to late winter. Summer annual weeds may be controlled by residual herbicides applied in the fall or winter or between cuttings, or by applications of foliar-active herbicides between cuttings.

B. Estimate of herbicides used and their cost:

Herbicide	Rate used a.i.*	% treated	Acres treated	Price/lb a.i.*	Cost per acre
Pronamide	1.0	1.5	67,500	$16.00	$16.00
Terbacil	0.4-0.6	.2	9,000	17.00	6.80-10.20
Simazine	1.5	3.0	135,000	4.00	6.00
Chlorpropham	4.0-6.0	.4	18,000	3.50	14.00-21.00
EPTC	2.0	5.0	225,000	3.60	7.20
2,4-DB	1.0	4.5	202,500	7.50	7.50
Benefin	1.0	0.3	13,500	6.00	6.00
Profluralin	1.0	0.1	4,500	7.00	7.00
Propham	4.0	8.0	360,000	2.20	8.80
Diuron	2.4	3.0	135,000	3.40	8.20
Paraquat	0.5-1.0	2.0	90,000	20.00	10.00-20.00
Total	-	30.0	1,350,000	-	-

* active ingredient

C. Pronamide in alfalfa grown for hay:

The principal use of pronamide in western forage alfalfa is for the control of downy brome. It also controls quackgrass, perennial ryegrass, annual bluegrass, and certain other broadleaf and grassy weeds. It is therefore effective in eliminating yield losses from weed competition and reductions in hay quality caused by the presence of weeds. It also prevents the damaging effect of downy brome awns in the hay.

D. Production benefits from use of pronamide.

1. Yield of total forage: Little change.
2. Value of forage produced: 10% increase. Although the total forage produced may not be changed, protein production is increased because downy brome and other weeds are replaced by legume. Value of increased quality is $32/acre.

E. Alternative herbicides.

When properly used, propham or combinations of paraquat with simazine, diuron, or terbacil will control downy brome. For control of downy brome following a fall seeding, only pronamide and propham can be used safely.

F. Non-chemical methods.

1. Cultivation. Vigorous tillage in late winter and early spring will control winter annual weeds; however, physical injury to the alfalfa crowns leading to increased susceptibility to disease accompanies such treatment.

2. Hand labor. Impractical.

3. Mowing. Weeds can be suppressed by mowing during the year of establishment of alfalfa. However, this treatment also retards the growth of alfalfa.

VI. Summary statement.

Most producers of alfalfa hay in the irrigated west sell their hay as a cash crop. Hay buyers are becoming increasingly demanding of high quality. Control of winter annual weeds is necessary to achieve the desired quality. Pronamide has proven to be a safe and effective herbicide for control of downy brome, which is the major weed problem of alfalfa in many areas. It is also especially useful for the control of quackgrass and certain other weedy grasses where they occur.

3.2.2 Pronamide for Weed Control in Alfalfa and Birdsfoot Trefoil Grown for Forage in the Upper Midwest and Northeastern States.

I. Acreage. 9,000,000 acres, principally in Wisconsin, Michigan, Pennsylvania, New York, Ohio, Indiana, Illinois, Minnesota, and New England.

II. Yield of hay. Average of 3.0 tons/acre per year.

III. Value of hay. $60/ton or $180/A per year.

IV. Weed problems. A variety of annual and perennial weeds are problems during the establishment of alfalfa and birdsfoot trefoil seedlings. Competition from these weeds suppresses the legume seedlings and may kill them. Once well established, the perennial legumes are vigorous and compete well with annual weeds. However, certain perennial weeds, especially quackgrass, can invade and proliferate in established stands of alfalfa and birdsfoot trefoil. The legume stands are thinned, and their productive life is shortened. Although quackgrass is palatable and fairly nutritious, it is less productive and less nutritious than the legumes. Therefore, its presence lowers the quality of hay and the yield of digestible dry matter for livestock. Quackgrass must be controlled for efficient production of quality hay.

V. Herbicides for weed control in alfalfa and birdsfoot trefoil.

A. When herbicides are used:

1. During establishment: Certain herbicides are used to control weeds during establishment. Most herbicides, except pronamide, that are selectively effective in established stands cannot be used safely in new seedings.

During establishment in areas having quackgrass, the ineffectiveness of the alternative herbicides for quackgrass control is important. The seedling legumes furnish little competition and quackgrass spreads vegetatively by rhizomes. Pronamide can be used during the fall of the establishment year to safely control quackgrass.

2. In established stands: The major weed is quackgrass, a vigorous perennial that cannot be controlled by non-chemical methods. The advent of pronamide opened the way to effective control of quackgrass in alfalfa and trefoil. There is also limited use of other herbicides for control of certain annual weeds and partial suppression of perennials.

B. Estimate of herbicides used and their cost:

Herbicide	Rate used a.i.*	% treated	Acres treated	Price/lb a.i.*	Cost per acre
Pronamide	1.0	0.3	27,000	$16.00	$16.00
Terbacil	0.4-1.2	0.1	9,000	17.00	7.00-20.00
Simazine	1.5	1.5	135,000	4.00	6.00
Chlorpropham	1.0	0.3	27,000	3.50	3.50
Dinoseb	2.0	0.1	9,000	2.65	5.30
EPTC‡	2.5	1.5	135,000	3.60	9.00
2,4-DB‡	1.0	2.5	225,000	7.50	7.50
Benefin‡	1.0	0.5	45,000	6.00	6.00
Profluralin‡	1.0	0.2	18,000	7.00	7.00
Total	-	7.0	630,000	-	-

* active ingredient

‡ These herbicides are not alternative herbicides for pronamide. They are effective only as pre-planting incorporated treatments or are ineffective on grasses.

C. Pronamide in alfalfa and birdsfoot trefoil:

Pronamide is the only herbicide that controls quackgrass and other perennial grasses selectively, either in the seedling year or after the legumes are established as perennials. It also controls annual grasses and certain broadleaf weeds. Pronamide is therefore becoming a vital production tool, useful in improving the production of the legume crop, and useful in total weed control on the farm because control of quackgrass in the hay crop benefits succeeding crops grown in rotation.

D. Production benefits from use of pronamide:

1. Yield of total forage: No change to slight increase.
2. Value of forage produced: 30% increase.

   Although the total forage produced is basically not changed protein production is increased because quackgrass is replaced by legume. Value of increased quality is $54/A.
3. Longevity of stand: 25% increase.

   On the average, stands of alfalfa and trefoil persist for 4 years. With quackgrass control, at least one additional year of productivity can be realized. If it costs $100/acre to establish alfalfa or trefoil, then the added value of extended longevity in reduced seeding cost is $20/A. In addition, the difference between yields during the seeding year versus that of an established stand of alfalfa is about two tons per acre. Two tons times $60 per ton equals $120/acre. This distributed over the five years longevity gives $24 per acre per year added value above the cost of seeding for use of pronamide.

4. Value in crop rotation: $10/acre.

   Control of quackgrass in alfalfa reduces its harmful effects in succeeding crops.

E. Alternative herbicides.

Some suppression of quackgrass in established alfalfa can result from simazine or terbacil. However, neither can be used during year of establishment, and neither controls quackgrass in established stands as well as does pronamide. Thus, pronamide is a superior treatment for which there is no alternative.

F. Non-chemical methods.

1. Cultivation: Not feasible.
2. Hand labor: Impractical.
3. Mowing: No value for quackgrass control.

VI. <u>Summary statement</u>.

Historically, the attitude of farmers toward quackgrass in legume forage crops has been one of tolerance. In the upper Northcentral and Northeastern states, quackgrass is almost universally present in forage legumes, and control measures have not been available. Furthermore, since the weed is eaten by livestock, and its presence has little effect on total tonnage of hay produced, the losses it has caused have not been dramatically evident. When the advent of pronamide made control of quackgrass possible, the benefits of control in terms of hay quality became apparent. The potential benefits of using pronamide to control quackgrass in alfalfa and trefoil far exceed the benefits yet realized.

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1. Cultivation: Not feasible!

Hand labor: Impractical.

3. ...: No value for ... control.

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3.2.3 Pronamide in Alfalfa Grown for Seed Production in Eight Western States.

I. Acreage. 205,000 acres in Washington, Oregon, California, Arizona, Utah, Idaho, and Montana.

II. Yield of seed. Average of 400 lbs/acre.

III. Value of seed. $1.00/lb or $400/acre per year.

IV. Weed problems. When grown for seed production, alfalfa is intensely cultured, similar to potatoes or sugarbeets. Weeds must be controlled for efficient production. Traditional methods of weed control during the year of establishment were based on periodic clipping. This treatment precluded the production of any crop during that year. Herbicides now have replaced clipping and have made it possible to produce good yields of seed during the year of establishment. Weeds continue to be a problem during the life of the stand of the perennial crop. These must be controlled to eliminate yield losses from weed competition, and from losses during harvest and cleaning due to the presence of weed material. Furthermore, weed seeds in alfalfa seed decrease the value of the product.

V. When herbicides are used:

1. During establishment: Nearly all alfalfa seeded for seed production is now treated with one or more herbicides for weed control during the seedling stage.
2. In established stands: After alfalfa is established, various herbicides are used to provide control of winter

annual weeds, summer annual weeds, perennial weeds, and parasitic weeds.

B. Estimate of herbicides used and their cost:

Herbicide	Rate used a.i.*	% Treated	Acres Treated	Price/lb a.i.*	Cost per acre
Pronamide	1.0-1.5	10	21,000	$16.00	$16.00-24.00
Paraquat	1.0	5	10,000	20.00	20.00
Chlorpropham	6.0	20	41,000	3.50	21.00
Propham	4.0	5	10,000	2.20	8.80
EPTC	2.5	15	31,000	3.60	9.00
2,4-DB	1.0	20	41,000	7.50	7.50
Diuron	2.4	10	21,000	3.40	8.00
Simazine	1.0	5	10,000	3.00	3.00
Terbacil	0.5	1	2,000	17.00	8.50
Benefin	1.0	5	10,000	6.00	6.00
Trifluralin	.75	10	21,000	7.60	5.70
Dinoseb	2.0	5	10,000	2.65	5.30
Dichlobenil	2.0	1	2,000	14.00	28.00
DCPA	10.0	10	21,000	3.50	35.00
Total	-	80**	164,000	-	-

* Active ingredient

** Sum of percents treated exceeds 100% because of treatments to same field with more than one herbicide.

C. Pronamide in alfalfa grown for seed production:

Pronamide controls annual grass weeds such as downy brome and is the only herbicide available for control of perennial grasses such as quackgrass. Furthermore, pronamide is effective for control of the parasitic weed, dodder.

D. Production benefits from use of pronamide:

1. Yield of total seed: 30% increase.

   Seed production of alfalfa is sensitive to the suppressing effect of weed competition. An increase in seed production usually accompanies any significant measure of weed control. The control of dodder can mean the difference between producing a crop and not producing a crop because of the devastating effect of this parasitic weed.

2. Value of seed produced: 5% increase.

   The presence of weed seed in alfalfa seed reduces its value in the market place. The presence of certain noxious weed species can preclude certification and force alfalfa to be sold at a reduced price. The value of increased quality is $20/acre.

3. Longevity of stand: 20% increase.

   Stands of alfalfa grown for seed production are less dense than stands of the same crop grown for forage. Weeds can invade the thin stands and shorten the life of the stand. Weed control with pronamide can prolong

the productive life of the stand by 1 year. If the average stand persists for 5 years at the cost of $150 per acre to establish alfalfa, then the added value of extended longevity is $25/acre.

E. Alternative herbicides.

Several of the materials listed under V-B will control the same weeds controlled by pronamide. However, pronamide is especially safe in alfalfa and controls certain major weeds, including dodder, selectively.

F. Non-chemical methods.

1. Cultivation: Where alfalfa is grown in rows, cultivation can play a major part in total weed control. However, herbicides are still needed for weed control within the crop rows.
2. Hand labor: Hand labor is extremely expensive. It can logically be used only to remove low populations of weeds that have escaped herbicides applications.
3. Mowing: Impractical for weed control in established alfalfa, and when used for weed control in new seedlings, it precludes the production of any crop during the year of establishment. This practice has been replaced by herbicides.

VI. Summary statement. Weed control is a vital part of the cultural practices necessary for the production of alfalfa seed. A high level of weed control is necessary to obtain favorable yield and quality. Pronamide is one of several herbicides of value in production of alfalfa seed. For effective control of the perennial grasses, it is the most effective herbicide available and the only one which can be safely used during the establishment year.

3.3.2.4 Pronamide for Weed Control in Clover Grown for Seed in Oregon.

I. Acreage and yield. Red clover, crimson clover, white clover, arrowleaf clover.

	Acres	Yield/lb/A
Red clover	15,000	260
Crimson clover	11,000	320
White clover	5,000	310
Arrowleaf clover	1,000	340
Total	32,000	-

II. Value of seed to producer.

Red clover	$.70/lb
Crimson clover	.25/lb
White clover	.75/lb
Arrowleaf clover	.40/lb

III. Weed problems. Clover seed production is a highly specialized enterprise in an area where weed problems abound. These weeds must be controlled to eliminate yield losses from competition and to assure production of high quality seed free of contamination by weed seed.

IV. Herbicides for weed control in clover grown for seed.

A. When herbicides are used:

1. During establishment: Herbicides are used to prevent devastating competition from weeds during seedling establishment.

2. In established stands: Winter annual weeds, summer annual weeds, and perennial weeds all are troublesome in clover seed production. Herbicides must be used each year to protect the crop from the effect of these weeds.

B. Pronamide in clover grown for seed:

Pronamide is the only available herbicide for selective control of perennial grasses. It also controls annual grasses. Approximately 25% of the established acreage is treated each year. Clover seedlings are tolerant of pronamide after the first trifoliate leaf is present. Therefore, the herbicide can be used safely for control of perennial and annual grasses during the season of seedling establishment, as well as in subsequent years.

C. Production benefits from use of pronamide:

1. Yield of seed: 100% increase
2. Value of seed: 10% increase

D. Alternative herbicides:

1. Propham at 4 lb/acre can be used both in the year of seeding and in subsequent years. Performance is erratic in both cases. Moreover, propham has only limited effect on perennial grasses.
2. EPTC at 2 to 3 lb/acre can be used as a preplanting incorporated treatment for seedling establishment to control annual grasses and certain broadleaf weeds. EPTC may retard development of clover seedlings, and thereby make them more subject to winter injury.

In established stands: Winter annual weeds, summer annual weeds, and perennial weeds all are important in clover seed production. Herbicides must be used and [illegible] to protect the crop from [illegible] control of [illegible]

[illegible] in clover grown for seed:

[illegible] is the only available herbicide for selective [illegible] of perennial grasses. It also controls annual [illegible]

Approximately [illegible] of the established acreage is [illegible] each year. Clover seedlings are tolerant of [illegible] after the first trifoliate leaf is present [illegible], the herbicide can be used safely for control of [illegible] and annual grasses during the [illegible] of establishment, as well as in subsequent years.

[illegible] benefits from use of [illegible]:

Yield of seed: 100% increase

2. Value of seed: [illegible] increase

[illegible] herbicides:

1. Pronamide [illegible] is used both in the year of seeding and in subsequent years. Performance is [illegible] in most cases. However, pronamide [illegible] control of perennial grasses.

[illegible] is used as a preemergence [illegible] for controlling [illegible] and [illegible] broadleaf weeds.

3. Paraquat at 1 lb/acre can be applied to established clover during the winter dormant season or after cutting. It is effective on annual grasses, but does not control perennial grasses.

Some herbicides can be used in clover to do part of the job done by pronamide. However, none of them are as versatile or as generally effective. Pronamide is the only material that offers effective and consistent control of perennial grasses, while at the same time controlling annual grasses.

E. Non-chemical methods:

1. Cultivation: Not feasible.
2. Hand labor: Not feasible.
3. Mowing: Impractical because it only retards perennial grasses without controlling them. Furthermore, in much of the area of clover production, machinery cannot operate on the field during the rainy season when control is needed.

V. Summary statement. The production of clover seed is a specialty industry in Oregon. Oregon growers supply seed effectively and economically for much of the area of the U.S. where clovers are used for forage. Economical production of clover seed demands a high degree of weed control. The area of clover production is subject to infestation by several troublesome perennial weed grasses as well as annual grasses and broadleaf weeds. The advent of pronamide has made it possible to control the perennial grasses in the year of seedling establishment and in subsequent years. No other herbicide available will provide this type of control. Therefore, pronamide represents a vital production tool in the production of clover seed.

premerge at 1 lb/acre ... clover during the winter dormant season or after cutting. It is effective on ... but does not control perennial grasses.

herbicides can be used in clover to do part of the job ... done by pronamide.* However, none of these ... as generally effective. Pronamide is the only ... that offers effective and consistent control of ... grasses ... in this crop ...

-chemical methods:

Cultivation: Not feasible.

Hand labor: Not feasible.

Mowing: Impractical because it only ... grasses without ...

much of the area of clover production, ... cannot operate on the field during the rainy season when control is needed.

... The production of clover seed is ... Oregon. Oregon growers supply seed ... for much of the area of the U.S. where clovers are ... production of clover seed demands a high ... the need of clover products ... on ... several troublesome perennial weed grasses ...

3.3 Production of Blueberries and Caneberries

3.3 Pronamide for Weed Control in Blueberries, Blackberries, Black Raspberries and Red Raspberries Grown in Oregon and Washington.

I. Acreage: 9,750 acres harvested

II. Yield and value: (from the Oregon Crop and Livestock Reporting Service, Berry Crop, 1976 Annual Summary, released January 20, 1977, U.S. Dept. Agr., Statistical Reporting Service, 1735 Federal Bldg., 1220 S.W., 3rd, Portland, OR 97204).

Caneberries and blueberries: Area, yield, production, price, and value, by states, 1976 (preliminary).

Crop and State	Area Harvested (acres)	Yield per Acre (pounds)	Production Utilized (1000 lbs)	Grower Price per Pound(¢)	Value ($1000)
Blackberries, cultivated					
- Oregon	2,600	8,190	21,300	29.0	6,177
- Washington	190	7,100	1,350	29.1	393
TOTAL	2,790		22,650		6,570
Blueberries					
- Washington	750	5,000	3,750	41.3	1,549
Black Raspberries					
- Orgeon	1,200	1,500	1,800	49.4	889
- Washington	110	830	91	50.0	46
TOTAL	1,310		1,891		935
Red Raspberries					
- Oregon	2,000	4,500	9,000	31.8	2,862
- Washington	2,300	6,260	14,400	29.4	4,234
TOTAL	4,300		23,400		7,096
GRAND TOTAL	9,150		51,691		16,150

III. Weed problems: Excellent weed control is very important for production and management of blueberries and caneberries. These plants persist for 10 to 15 years. Mechanical harvesting is done on approximately 90% of the black raspberries, 40% of the red raspberries and 75% of the blackberries. With mechanical harvesting, no weed seeds (awns of brome are particularly troublesome) are allowed since these cannot be removed.

A number of herbicides are used because each controls a specific spectrum of weeds. Most acreage receives at least two different herbicides in one year.

IV. Herbicides for weed control in blueberries and caneberries:

A. Herbicides used:

Herbicide	Rate used a.i.[a]	% Treated	Acres Treated	Price/lb ($) a.i.[a]	Price/A ($)
Pronamide	2	35[b]	3,413	16.00	32.00
Simazine	4	50	4,875	3.00	12.00
Diuron	1.6	50	4,875	3.40	5.44
Dichlobenil	4	17	1,658	14.00	56.00
Paraquat	1	50	4,875	20.00	20.00
Dinoseb	2.5	12	1,170	2.65	6.63
Chlorpropham	12	1	98	3.50	42.00
Terbacil	3	0.05	5	17.00	51.00

a a.i. = active ingredient

b Rohm and Haas sales estimates are that 5,000 pounds of a.i. pronamide was sold in 1976; this would account for about 25% of the acreage treated. Agricultural scientists from Oregon and Washington estimate about 50% of the acreage is treated. Therefore, a compromise figure of 35% was used.

B. Pronamide in blueberry and caneberry production: Pronamide is used because it is the most effective herbicide for control of quackgrass (a perennial that spreads rapidly by rhizomes) and annual winter grassy weed problems. Since these plantings are maintained for up to 15 years, quackgrass competition must be continually checked. Cultivation will not eliminate the grassy weed problem adjacent to the berries. Cultivation is difficult because of excessive moisture and because it cannot remove weeds growing among the multiple canes of the plants; pronamide kills the grassy weeds and the resulting dead weed foliage aids in erosion control. Pronamide is applied by ground equipment in the fall at the start of the rainy season.

C. Alternative herbicides to pronamide: There are none as effective as pronamide for quackgrass control. Dichlobenil had been used with marginal success. The rates registered are not sufficient for season long control. Furthermore, repeated application of dichlobenil and simazine has caused a decline in vigor of berry plants.

D. Cultivation as an alternative: Not effective because cross row cultivation is not possible due to the hedge-like plantings and in many cases, trellising.

E. Hand weeding: If pronamide were cancelled, quackgrass could not be selectively controlled because of its rhizomatous habit of growth.

because it is the most difficult [illegible] control

[illegible] in [illegible] it must [illegible]

small grain [illegible] weed problems. [illegible] these [illegible]

infested [illegible] up to 15 years, quackgrass [illegible]

be continually checked [illegible] will not eliminate

[illegible] problem adjacent [illegible]

[illegible] because of excessive moisture and [illegible]

cannot remove weeds growing among the mulch [illegible]

area; perennials like the grassy weeds [illegible]

weed foliage able to [illegible] control. [illegible] is [illegible]

ground equipment in the fall at the [illegible]

[illegible] herbicides [illegible] There [illegible]

recommended for quackgrass [illegible]

with marginal success. The rates required are

[illegible] for season long control. [illegible]

[illegible] of [illegible] and [illegible]

[illegible] The effective [illegible]

row [illegible] is not possible due to the hedgerow [illegible]

V. Production benefits from use of pronamide:

A. Where quackgrass exists, and pronamide cannot be used, it is estimated that there would be a 15% acreage reduction.

B. Value of mechanically picked berries would be reduced 25% because of awn and weed contamination.

C. Longevity of stand would be reduced 30%.

VI. Factors contributing to safe use of pronamide:

A. Safety to the applicator: Pronamide is applied once a year in the fall. The applicator being more fully clothed than at mid-summer is, therefore, more adequately protected from herbicide contact. Other workers are not in the field at the time of spraying.

B. Time interval and height differential prior to berry harvest: Pronamide is applied in mid-autum over 6 months before berries are harvested. Rains in the intervening time wash pronamide into the soil. Therefore, field workers are not exposed to pronamide in significant amounts. Furthermore, there is a height differential of from one to four feet from the treated soil to the berries that are picked.

VII. Concluding statement:

Pronamide has become an invaluable weed control tool for blueberry and caneberry production in Oregon and Washington. This is verified by the fact that an estimated 35% of the

acreage is treated with pronamide. Pronamide is a highly effective herbicide for quackgrass (an ubiquitous perennial grass species in the Northwest); there are no other herbicides that are as effective. Mechanical harvesting necessitates weed-free plantings; otherwise weed-seed contaminated fruit cannot be sold.

Due to the hedge row planting, cross cultivation is not practical. The continued use of pronamide is necessary to maintain the present adequate acreage of these crops to supply demands for high quality fruit.

3.4 Woody Ornamentals and Christmas Tree Production

3.4 Pronamide for Weed Control in Woody Ornamentals and Christmas Tree Production in the United States

I. Acreage.[1]: 307,700

II. A. Value[1]: Wholesale income directly from growing = $559,400,000; retail value of plants produced = $1,560,930,000

B. Number of firms[1]: 5000

C. Total Employees[1]: 117,010

III. Weed problems: Woody ornamentals represent a wide range of species; thus a number of different herbicides are needed for selective removal of annual and perennial weed problems. Pronamide is used because it offers a high degree of selectivity on the many ornamental species and controls a range of weed problems in the Northern and Central tier of States. Pronamide is highly effective in controlling quackgrass (perennial), annual bluegrass and downy bromegrass (annual) (Appendix Documents 12-16). These grassy weed species must be controlled to promote the growth and development of woody ornamentals.

IV. Herbicides for weed control in woody ornamentals and Christmas trees:

A. Herbicides are used in the establishment and maintenance of these perennial crops. Estimates of herbicides used and their costs are presented in the following table.

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[1] Data obtained from "Research Summary - Scope II of the Nursery Industry published by the Horticultural Research Institute, Inc., 230 Southern Building, Washington, DC, 1973. p. 24.

Table 1. Herbicides used in ornamental and Christmas tree plantings, showing average rates per acre, estimated acres treated, and price per acre of herbicide treatments.

Herbicide	Rate used a.i.[a]	% treated[b]	Acres treated	Price/lb a.i.	Cost per acre
Pronamide	1.5	5.4[c]	16,700	$16.00	$24.00
Dichlobenil	4	15	46,155	17.00	68.00
Simazine	2.5	65	200,005	3.12	7.80
Oryzalin	4	10	30,770	9.33	37.32
Trifluralin	4	10	30,770	7.21	28.84
Diphenamid	7	5	15,385	6.50	45.50
Paraquat	1	10	30,770	17.50	17.50
EPTC	5	5	15,385	3.04	15.20
DCPA	12.0	5	15,385	3.93	47.16
Dinoseb	4.5	0.5	1,538	1.90	8.55
Chlorpropham	6	0.5	1,538	3.63	21.78

[a] a.i. = active ingredient

[b] Estimates are based on a selected telephone survey of scientists knowledgeable in ornamental weed control in various regions of the United States.

[c] This figure is based on Rohm and Haas estimate of sales of pronamide on these crops.

B. Production benefits from use of pronamide

If pronamide were banned growers of ornamentals and Christmas trees would need 30,000 acres of additional land, which could be fallowed to reduce quackgrass infestations prior to out-planting of their nursery stock.

Where quackgrass is a problem, ornamental nursery production would have to be curtailed. To control quackgrass, fallow tillage control would have to be done for at least two years prior to establishment; this would mean 30,000 acres (10% of the 307,700 A) more land would be idle while quackgrass was controlled. Within a 3 to 5 year period quackgrass would be expected to reestablish. Eradication of a perennial is a rare event. Some states (Oregon, for example) have noxious weed laws which prohibit the interstate shipment of ornamentals contaminated with quackgrass. Fallow land control of quackgrass really would not be very effective in most seasons in the Northeast. In wet weather clean cultivation merely transplants the rhizomes. Cost is the biggest factor. Annual weed control costs $200 to $300 per acre in cultivated ornamentals, but quackgrass control (by hand and mechanical methods) could be expected to cost another $200 per acre, for a total cost of perhaps $400 to 500 per acre. If mechanical and hand removal methods are used, plant losses (hoe and cultivator damage) would approach 15 percent. In other words, 15 percent or more of the crop would be lost. Based on a plant population of 10,000 per acre worth $5 each at digging, a 15 percent loss would cost a grower another $7500 per/A. Therefore, if quackgrass is not properly controlled, with an herbicide such as Kerb, grower losses could approach $8000 per acre during a rotation. Losses would be greater if labor were not available to do the hoeing and weeding.

2. Erosion control: Pronamide and dichlobenil are the only herbicides which selectively kill grassy weeds after they have emerged. The resulting dead foliage of the weeds (which is not disturbed) aids in erosion control.

quackgrass is a problem, cultural [illegible] [illegible]
have to be controlled. In control operations, follow-
[illegible] control would have to be [illegible] for [illegible] years after
establishment; this would mean 20,000 acres (10% of the
201,700 A) more land would be [illegible] while [illegible] cost [illegible]
in a 3 to 5 [illegible] period [illegible] would be [illegible]
establish. Eradication of a perennial is a [illegible]
(Greece, for example) [illegible] [illegible] [illegible]
[illegible] of [illegible] [illegible] [illegible]

Actual weed control costs [illegible] per acre in
[illegible] but [illegible] control [illegible]
[illegible] could be expected to cost another $200 [illegible]
[illegible] for a total cost of perhaps [illegible]
[illegible] are used, [illegible]
cultivator damage) would approach [illegible] other [illegible]
15 percent or more of the crop would be lost. Based on a plant
population of 18,000 per acre [illegible]
effect loss would cost a grower another $1500 per [illegible]
usually is not properly controlled, with an herbicide [illegible]
grown [illegible] [illegible] per acre during a
process if labor were not available

[illegible] are the only [illegible]

C. Alternative herbicides: Some suppression of quackgrass and annual grassy weeds, such as downy bromegrass can result from treatments of dichlobenil and simazine. However, the effectiveness of dichlobenil and simazine are limited. Of the two, dichlobenil offers better quackgrass control; however, the number of crops to which it is selective is limited; the rate of dichlobenil used is not sufficiently high to effect season long quackgrass control. Downy bromegrass is remarkably well controlled with low rates of pronamide; no other herbicide offers downy bromegrass control at similar low rates. Thus, pronamide is a superior treatment for these special weed problems for which there is no reasonable alternative.

D. Non-chemical methods

1. Cultivation - would require loss of cropland use for two growing seasons while fallow cultivation was used to reduce quackgrass and other perennials the year prior to establishment of the ornamental or Christmas tree plants. Fallow tillage would not be effective in most of the Northeastern States due to wet weather. Cultivation would merely transplant the rhizomes.

2. Hand labor - impractical.

3. Mowing - No value for quackgrass control.

V. Safety to the applicator: Most of the pronamide is applied as a granular formulation which minimizes the inhalation and other exposure to the applicator. This chemical must be applied in the cool part of the year (fall or winter); thus the applicator has more clothing on and this offers greater protection against exposure.

VI. Concluding statement: Pronamide is a relatively new herbicide with usage increasing progressively each year. Use of pronamide is for a specific weed spectrum (annual grasses and quackgrass which is a perennial grass) not selectively and safely controlled by the alternative herbicides. If pronamide were not available for these uses, production would be curtailed or restricted to those areas where quackgrass is not present.

3.5 Turf

3.5 Pronamide In Turf

Pronamide is widely used in turf in the southern states where golf courses and other athletic fields are almost exclusively bermudagrass (Cynodon dactylon L.). It is estimated that 25-thousand acres of such turf is treated. Pronamide's usefulness and the impact of its ban can be gleaned from summaries of conversations with several turf and weed specialists of the Southeastern U. S.

Dr. William Lewis, North Carolina State University, Raleigh, N.C. Pronamide is used mainly on golf courses on bermudagrass. Pronamide is effective for the control of annual bluegrass (Poa annua L.). It is effective as preemergence treatments, early postemergence and on established annual bluegrass stands (in order of decreasing effectiveness or higher rates required). It also effectively controls chickweed, corn speedwell, henbit and some cresses.

Alternate herbicides are all less effective and have less flexibility in timing of treatments than pronamide. DCPA and bensulide are moderately reliable if treatments are applied before germination of annual bluegrass - time of germination is variable, therefore in many years the proper timing of treatments is missed.

Dr. E. O. Burt, Florida Agri. Exp. Station, Fort Lauderdale, Florida. Specific use of pronamide is for annual bluegrass control in bermudagrass. It is tremendously successful both as pre and postemergence treatments at 1/2 to 1 pounds per acre active ingredient.

Most golf course superintendents and managers of athletic turf areas use pronamide. Well over 50% of the bermudagrass turf infested with annual bluegrass is treated. There is no effective and reliable substitute.

Bermudagrass is the turf species used in over 90% of the athletic fields and golf courses of the South, over 99% in Florida.

A practice used to a limited extent is a treatment of pronamide on bermudagrass putting greens in the fall to control annual bluegrass followed about 4 to 6 weeks later by a treatment of activated charcoal, 5 lb/100 sq. ft., and overseeding with a cool-season grass species.

Annual bluegrass germinates throughout the fall and winter which makes proper timing of herbicides such as DCPA and bensulide difficult to attain and therefore these treatments are too unreliable to be considered as real alternatives to pronamide. Neither DCPA nor bensulide are effective as postemergence treatments. DCPA is not effective on muck soils or if significant thatch is present.

<u>Dr. Coleman Ward, University of Florida, Gainesville, Florida.</u>
The only herbicide effective both as preemergence and postemergence treatments for annual bluegrass control in bermudagrass turf is pronamide. About 90% of the golf courses and athletic fields in the South use bermudagrass. Pronamide is used almost exclusively for annual bluegrass control in these areas. It is widely used in the upper- and mid-south.

About half the Florida golf courses overseed to cool season grasses. Even here pronamide is used with a waiting period after

treatment before overseeding. Research in Florida shows that a waiting period of as little as 15 days is adequate if activated charcoal is used at seeding time.

Other herbicides are effective only as preemergence treatments. If germination of annual bluegrass is delayed too long after treatment, or if it has germinated ahead of treatment, inadequate control results. Therefore, these herbicides are not reliable enough to be considered alternatives to pronamide.

Dr. G. Euel Coats, Mississippi State University, State College, Miss. Pronamide is the only herbicide available that is effective as both pre and postemergence treatment for control of annual bluegrass. Its use is much more frequent along the southern coast, in resort areas, and in areas of high population where high quality turf on golf courses can be justified and afforded by the owners. In areas of lower population and where the requirement for high quality turf does not justify high expenditures for quality turf, use of pronamide and other herbicides is low. Where pronamide is used in these latter situations it is used in January and February, in combination with herbicides such as silvex for broadleaf weed control, to cleanup the turf in preparation for spring growth of bermudagrass.

In some areas of the mid-south, it is probable that some paraquat may be used, while the bermudagrass is dormant, to clean up annual bluegrass and other annual weeds before spring growth of the turf.

Many athletic fields of the mid-south do not use appreciable amounts of herbicides. Many of these are overseeded with cool season grasses during the fall and winter.

Dr. Ray Dickens, Auburn University, Auburn, Alabama. Pronamide is the only herbicide registered for use in bermudagrass turf that will reliably control annual bluegrass. Simazine, which is not labeled for such use in turf, will control annual bluegrass.

Annual bluegrass is a very serious problem and is becoming much more so with the more intensive turf management programs being used to meet requirements of golfers. If no control is accomplished, the annual bluegrass continues growth until early summer and effectively suppresses growth of the bermudagrass. When weather becomes hot and/or dry the annual bluegrass all dies at once, leaving essentially nothing for three or four weeks until the bermudagrass makes enough growth to provide ground cover.

Pronamide also is used in the fall and early winter on bermudagrass greens to kill annual bluegrass followed in 4 to 6 weeks with activated charcoal treatment and overseeding with cool season grasses.

Such herbicides as DCPA and bensulide frequently are applied either too early or too late relative to the time of germination of annual bluegrass to effectively control it. In addition, these herbicides frequently add stress to the bermudagrass plants and suppress rooting of the nodes of bermudagrass stolons so that the turf is thin and does not "heal over" rapidly from divots and other soil disturbances.

The potential usefulness of pronamide for other athletic fields is largely unexploited in Alabama. Where it is used, improved turf quality results.

Dr. Richard Duble, Texas A&M University, College Station, Texas. Pronamide is widely used in Texas, primarily in golf courses. It is the only herbicide for which timing of treatment is not critical for annual bluegrass control. If annual bluegrass is not adequately controlled, it suppresses growth of the bermudagrass in the spring which allows crabgrass to invade the turf during the summer.

On fairways, alternative herbicides such as DCPA and bensulide are effective for the control of annual bluegrass about 60-70% of the time. They are effective if application is made soon before annual bluegrass germinates. However, time of germination is variable and so far has been unpredictable so that the preemergence treatments often are made too early or too late to be effective. A failure rate of 30-40% is intolerable on golf courses because of demands for high quality turf by the clientele.

Pronamide is the only herbicide that can be used for control of annual bluegrass on greens. About 95% of such greens are overseeded. Overseeding is done after annual bluegrass is cleaned up by pronamide, with a waiting period of 60-90 days after treatment. There is no alternative control method for annual bluegrass on greens.

applications of pesticides for other [illegible]

complicated to [illegible]. [illegible] it is used [illegible]

[illegible] widely used, [illegible]

[illegible] herbicides for which [illegible]

a bluegrass control. [illegible]

[illegible] grass growth [illegible]

[illegible] grass to invade the turf during the summer.

[illegible] 3, alternative herbicides such as DCPA and bensulide [illegible]

for the control of annual bluegrass [illegible]

are effective if application [illegible]

[illegible], however, time of [illegible]

crabgrass [illegible] the [illegible]

or too late [illegible]

able on golf courses because of [illegible]

greens.

is the only herb [illegible]

[illegible] on greens. [illegible] of such greens [illegible]

[illegible] is done after annual bluegrass [illegible]

[illegible] 60-90 days after treatment. [illegible]

[illegible] annual blue[illegible]

Exposure of the public to pronamide. Pronamide is a 50% wettable powder applied to turf areas once a year at 1/2 to 1 pound per acre active ingredient. Twenty to 50 gallons per acre of aqueous spray is applied by ground equipment. Other than the spray operator, who may occasionally be exposed to a small amount of spray drift, the public is not exposed to the spray. Spray particles that may be intercepted by the grass foliage are washed off by rain or irrigation water into the soil. After this, chances for exposure of any person or animal to the herbicide are remote.

Chapter 4

AN ECONOMIC ANALYSIS OF THE COSTS OF PROHIBITING THE USE OF PRONAMIDE ON ALFALFA AND LETTUCE

I. Objective and Outline of the Analysis. Estimates of the short-run economic losses to agriculture of prohibiting the use of pronamide, a herbicide especially suited to the control of perennial grasses and certain broadleaf weeds are developed in this section. Pronamide is used on most lettuce fields; many seed clover fields; occasionally on alfalfa fields; and also on berries, woody ornamentals and turf production. Estimates are made of the increased costs of producing alfalfa and lettuce, the two crops on which approximately 90 percent of domestic use of pronamide occurs. General limitations of the analysis are discussed in Section II. The analyses of the economic losses of producing alfalfa and lettuce, without pronamide are presented in Sections III and IV, respectively. The analysis is summarized in Section V.

II. General Limitations of the Analysis. The following analysis considers the short-run economic losses from prohibiting the use of pronamide within a framework which assumes competitive market pricing, resource mobility, and no externalities. These are standard assumptions in economic analysis,but deserve explicit discussion.

Resources are not instantaneously mobil. Labor,entrepreneurs, and capital shift between crops and growing regions, but change takes time. In the meantime, there is disequilibrium. Too much acreage may be

planted to a crop, prices fall, and returns are reduced so farmers shift to other crops; or too many farm workers may stay in a region of declining production because they do not have the financial resources to relocate. This analysis, though short-run, assumes resources adjust instantly and without cost. Furthermore, regions and, to a lesser extent, crops are aggregate. A total U.S. perspective is presented which may not be relevant to a local area faced with a shift in crops. To the extent that adjustment itself is costly, this analysis underestimates the impact of prohibiting the use of pronamide.

The analysis considers only private benefits and costs. Externalities, social benefits and social costs which are not reflected in market prices are excluded. This is a major limitation since the concern that pronamide may be a carcinogen is the motivating force behind the Environmental Protection Agency investigation into whether or not the herbicide should be banned. The analysis ignores this possible social cost as well as social costs and social benefits associated with alternative chemicals, farming practices and land uses. Since it is difficult to measure the social costs of possible carcinogenicity, the impact of a pronamide ban (private benefits less private costs) must be weighed against the perceived risks associated with uses of pronamide.

Lastly, pronamide is a fairly new, unique, and not yet extensively used herbicide. A large portion of the pronamide is used in lettuce, berries, alfalfa, and seed clover, and woody ornamental production. These are

highly specialized crops. For these reasons, there has not been nearly as much research undertaken as for a major pesticide on a major crop. The best estimates available are those of agricultural scientists working in the area and they were used in this study. In the case of lettuce, there is insufficient understanding of market conditions to make a single prediction, consequently several scenarios are considered.

III. The Economic Costs of Eliminating Pronamide Use on Alfalfa 1/

Introduction. Pronamide is used on approximately 116,000 acres in alfalfa production (Table 4-1). This use amounts to an estimated 1.5 percent of the alfalfa hay and 10 percent of the alfalfa seed acreage in the Western states and 0.3 percent of alfalfa and birdsfoot treefoil acreage cultivated for hay in the upper Midwest and Eastern states. Pronamide is used largely to control annual grasses in the West, and quackgrass and other perennial grasses in the upper Midwest and Eastern states, which invade alfalfa fields. Other herbicides also are effective on annual grasses. But pronamide is particularly effective on perennial grasses, such as quackgrass, and on broadleaf weeds, such as weed dodder, on which other herbicides are substantially less effective.

Initial Direct Effects on Production Costs and Revenues. Summary data on U.S. alfalfa production and estimates of changes in yields, quality, and weed management costs with pronamide and without any herbicides are presented in Table 4-1. These yield and cost estimates are used to

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1/ Data for this section of the analysis were compiled by Jean H. Dawson, Research Agronomist, U.S. Agricultural Research Service, Irrigated Agriculture Research and Extension Center, Prosser, Washington.

specialized crops. For these reasons, there has not been as much research undertaken as for a major pesticide on [illegible] crops. The best estimates available are those of agricultural [illegible] working in the area and they were used in this study. [illegible] lettuce, [illegible] is insufficient [illegible] to make a single prediction. [illegible]

[illegible]

[illegible]. Pronamide is used on approximately [illegible] production (Table [illegible]). This [illegible] of the alfalfa hay and 10 percent [illegible] in the Western states and [illegible] percent of alfalfa [illegible] acreage cultivated for hay in the [illegible] states. Pronamide is used largely on [illegible] grasses in the [illegible] quackgrass and other perennial grasses in the upper [illegible] states, which invade alfalfa fields. Other herbicides are effective on annual grasses, but pronamide [illegible] perennial grasses, such as quackgrass, [illegible] as weed dodder, on which other herbicides are [illegible]

[illegible]

[illegible] and estimates of changes in yields, quality [illegible] with pronamide and without any herbicides are [illegible]. These yield and cost estimates are [illegible]

[illegible]

derive initial estimates of economic loss to alfalfa growers presented in Table 4-2. The initial estimates assume no price or acreage changes--assumptions which will be explored in the subsequent section. The efficacy data provided compare the use of pronamide with no herbicide. But clearly other herbicides are available and will be used by the majority of growers who have weed problems on which they are effective, but they are not adequate for quackgrass control. Nevertheless, estimates are also derived on assumption that, for alfalfa growers who now use pronamide, alternative herbicides are available which are two-thirds as effective and equal in cost to the average herbicides currently applied by alfalfa growers. This assumption may overestimate the effectiveness of alternatives where perennial grasses are involved.

The amount of loss is clearly overestimated if one assumes that alfalfa growers now using pronamide have no alternatives. For the purpose of this analysis the assumption that an alternative exists is superior to the assumption of no alternatives for pronamide. The weed scientists on the assessment team contributed to the development of this assumption.

Price Effects, Acreage Shifts, and Impacts on Other Crops. Prohibiting the use of pronamide in alfalfa hay production would likely reduce total hay production by about 0.05 percent in the West and by a smaller percentage in the Midwest and the East. Even in the unlikely event that all pronamide users on alfalfa hay switched to other crops because of the higher profit potential given a pronamide prohibition, the reduction in production from existing acreage would be about 1.5 percent in the

of Maryland lost . . .

b. The federal ban . . . ing to . . . ch . . .
. . . will be explored in the subsequent section. The
loss providers compare . . .
. . . by . . . ers
of growers who have used products on
acreage for quackgrass control.
. . . ed on assumption that . . .
alternative herbicides are available . . .
and equal in . . . to the overall . . .
. . . alfalfa growers. This assumption . . .
. . . terms . . . potential . . .

of loss in alfalfa . . .
. . . now using pronamide . . .
. . . on the assumption that an alternative . . .
. . . of no alternatives . . . The . . .
. . . assessment . . .

. . . pronamide in alfalfa hay production . . . likely reduce total
production about 0.03 percent . . . and by a smaller
percent in the . . . the East. . . .
. . . cent . . . ed . . .
. . . the . . .
. . . about 1.5 percent in . . .

West and 0.3 percent in the Midwest and the East 2/.

Since net losses per acre per year for pronamide users are estimated to be small on alfalfa hay, it is unlikely that many pronamide users will shift to other crops. Also, a negligible price change is expected for alfalfa hay. This suggests that prohibiting pronamide use on alfalfa hay will have little effect on growers not using pronamide in alfalfa production or producers of substitute crops.

The effects on the supply of alfalfa seed and, hence, on prices and incentives to nonusers of prohibiting the use of pronamide in alfalfa seed production are considerably greater than for hay, though still not large. The reduction in alfalfa seed production capability on existing acreage in production is probably about 1.0 percent. In the unlikely event that all users of pronamide on alfalfa seed switched to other crops because of higher profit potential given a pronamide prohibition, the reduction in alfalfa seed production from existing acreage would be about 10.0 percent. 3/

If alfalfa seed prices remained constant, the supply reduction would likely be between 1.0 and 3.0 percent since it is unlikely that all seed growers who used pronamide would shift to other crops. But since seed costs are an essential input and a small percentage of the cost in the production of alfalfa hay, the demand for alfalfa seed is

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2/ The most likely quantity reductions assume no acreage shifts, that alternative herbicides are available which are two-thirds as effective, and that pronamide users receive average yields. The unlikely high estimate only makes the last of these assumptions.

3/ See assumptions detailed in footnote 2, *supra*, p. 5

TABLE 4-1

Alfalfa Acreage, Herbicide Usage and Costs, and Yield Effects 2/

	Irrigated West		Midwest and East
	Hay	Seed	Hay
	- - - - - - - Thousand acres - - - -		
Acreage			
Using pronamide	68 acres	21 acres	27 acres
Using other herbicides	1,282 "	143 "	603 "
Total alfalfa acres	4,500 "	205 "	9,000
Average yield	5 tons per acre	400 pounds per acre	3 tons per acre
Average price	$65 per ton	$1 per pound	$60 per ton
Average revenue	$325 per acre	$400 per acre	$180 per acre
Pronomide use compared to use of no herbicide 2/			
Yield change	0 percent	+ 30 percent	0 percent
Quality change	+ 10 percent	+ 5 percent	+ 30 percent
Stand change	0 percent	+ 20 percent	+ 25 percent
Cost of applying pronamide at $16 per pound a.i. and $5 application	$21	$25	$21
Average costs per acre of alternative herbicide	$13	$23	$12
Costs of establishing alfalfa stand (every number of years)	$100(4)	$150(5)	$100(4)

1/This information was obtained from the biological information of the pesticide impact assessment for pronamide.

2/Expressed as a percent change from average yield or yield equivalent.

TABLE 4-2

stimates of changes in annual costs and returns per acre to alfalfa growers with se of alternative pesticides and no alternatives to pronomide 1/

	Irrigated West		Midwest and East
	Hay	Seed	Hay
		dollars/acre	
No alternative herbicide			
Revenue loss 2/	33	145	58
Cost decrease	21	25	21
Net loss	12	120	37
Assuming alternative herbicide 3/			
Revenue loss 2/	11	48	19
Cost decrease 4/	8	2	9
Net loss	3	46	10

1/ Based on Table 4-1
2/ Loss of revenue from yield decrease, changes in quality expressed in yield equivalent and difference in longevity amortized for different lengths of production using a 8% interest rate.
3/ Assumes alternative herbicide 2/3's as effective as pronamide
4/ Difference in cost between pronamide and

Table 4-3

Estimates of net losses to alfalfa growers with and without alternative herbicides by Region 1/

	Irrigated West		Midwest and East	Total
	Hay	Seed	Hay	
No alternative	$816,000	$2,520,000	$999,000	$4,335,000
With alternative	204,000	966,000	270,000	1,440,000

1/ Based on Tables 4-1 and 4-2

undoubtedly quite price inelastic. Assuming the price elasticity for alfalfa seed is -0.5, then the initial reduction in supply of 1.0 to 3.0 percent would result in a 2.0 percent to 6.0 percent price increase. This would encourage existing growers to increase yields as well as encourage others to produce alfalfa seed; thus, in turn, lowering prices somewhat. The net effect would likely be a small reduction in quantity--perhaps 0.5 percent to 1.5 percent--and a small increase in price--perhaps 1.0 percent to 3.0 percent.

Summary of Short-Run Economic Losses and Their Incidence in Agriculture

The expected small output and consequent small price adjustments due to the high price elasticity of demand for alfalfa hay mean that initial estimates of an economic loss of about $1.4 million per year appears reasonable. Other assumptions would lead to different estimates; but it seems unlikely these estimates would be less than $0.5 million or greater than $2.0 million per year. Because of the high price elasticity of the demand for alfalfa hay and the fact that alfalfa seed is an essential input to the production of hay, most of the burden of the economic loss will fall on hay producers now using pronamide due to low quantity and quality of yield and slightly higher seed costs. Hay producers not using pornamide and seed producers using pronamide will also bear some of the costs. Seed producers not using pronamide will benefit somewhat from slightly higher seed prices.

Longer-Term Impacts. The use of pronamide in alfalfa production has been increasing slowly since its introduction in 1972, and probably will continue to increase in the future, if not banned. Thus, the future losses are somewhat greater than those estimated for the short-run.

IV. The Economic Costs of Not Being Able to Use Pronamide on Lettuce 4/

Introduction. Pronamide is used on nearly all of the 65,000 harvested acres of lettuce in the Salinas Valley and on an estimated one-third of the 85,000 harvested acres of lettuce in the Imperial Valley and San Joaquin Valley regions of California. It is also used on a small acreage in Arizona. At an average application rate of 1.25 pounds a.i. per acre, lettuce accounts for about 26 percent of U.S. sales of pronamide. Pronamide is the preferred herbicide in lettuce production because it is effective on nearly all the weeds that invade lettuce fields in the coastal growing areas of Salinas, Santa Maria, and Oxnard in California and in the Imperial and Blythe winter lettuce areas. It does not suppress lettuce yields at normal rates of application, and does not need to be mechanically incorporated into the soil. Benefin is an alternative herbicide which is frequently used in the Imperial Valley for the summer grown lettuce where many growers rotate lettuce with wheat or other small grains whose yields are suppressed by the use of pronamide. Benefin is more effective than pronamide on many summer weeds.

Initial Direct Effects on Production Costs and Revenues. Available estimates for the Salinas Valley indicate yields would decrease by 10 percent, as much as 20 percent of the crop would be graded a lower

4/ Data used in this section of the analysis were compiled by Arthur N. Lange, Extension Weed Control Specialist, University of California, Kearney Field Station, Parlier, with the assistance of Harry Agamalian, Cooperative Extension, University of California, Monterey County.

quality, and weed control costs would increase $25 to $40 per harvested acre. 5/ With current yields of 33,000 pounds per harvested acre per crop in the Salinas Valley and prices at about $8.00 per hundred weight, the revenue losses from a yield reduction of 10 percent would amount to $264 per acre. In addition, quality losses of up to $132 per acre (5 percent of yield) might be incurred for a total revenue loss of $396 per acre. Adding the increased weed control costs to these estimates would result in an impact on lettuce growers for the 65,000 acres treated with pronamide in the Salinas Valley of $18.8 million ($264 revenue loss plus $25 herbicide cost per acre) to $28.3 million ($396 revenue loss plus $40 herbicide cost per acre) assuming no price or acreage shifts.

Lettuce yields in the Imperial and Blythe areas are about 23,400 pounds per acre per crop. It was estimated that about 28,000 acres of lettuce were treated with pronamide in these areas. Assuming that the yield, quality, and herbicide costs for the Salinas Valley are applicable for these areas, the economic impact on growers could range from $5.9 million to $9.0 million. For growers having only a yield reduction (10 percent) and increased herbicide costs of $25 per acre the change in revenue would be $212 per acre. Those growers having quality losses in addition to yield reduction (15 percent total) and increased herbicide costs of $40 per acre would incurr a revenue change of $321 per acre.

5/ Within the limited time frame of this analysis, it has been possible to assess how this quality loss would affect lettuce growers' revenues given existing grading standards, how these standards would change if existing standards were more difficult to meet, or how any of the above relates to consumer preferences in the longer run. Thus, for the purpose of this analysis, the lower grade for 20 percent of the crop is treated as equivalent to a 5 percent yield loss.

The total impact on lettuce growers in California using pronamide would range from $24.7 million to $37.3 million assuming no price changes or shifts in acreage to other crops.

Price Effects, Acreage Shifts, and Impacts on Other Crops. The ability to estimate price increases, acreage changes, and impacts on other crops is imprecise because of three unknown factors. First, suitable estimates of pronamide use and efficacy on lettuce are available only for the Salinas Valley. Second, no studies currently exist on acreage substitution between vegetable and related crops in the United States when there are relative price changes. Finally, available estimates of the price elasticity of demand for lettuce vary from as low as -0.10 when all lettuce production in the U.S. is taken into account to a high of -1.8 for California fall lettuce. 7/

The 15 percent yield and quality loss estimated for the Salinas Valley and Imperial and Blythe areas amounts to about 4.2 million hundredweight or about 10 percent of total U.S. annual production. To maintain supply, additional acreage would have to come into production. If this land were of similar quality to the existing acreage, prices would have to increase by at least 10 percent and probably would need to be slightly higher to bid land away from competing crops.

For example, a price increase of 12 percent (from $8.00 to $9.00/cwt) would cost lettuce consumers, most of whom are in the United States, a

7/ The lower estimate occurs in Table 11 of P.S. George and G.A. King, Consumer Demand for Food Commodities in the U.S. with Projections for 1980, University of California, Giannini Foundation Monograph No. 26 (Berkeley, 1971). The higher estimate is derived from a preliminary unpublished report of the Giannini Foundation using 1974 prices and quantities.

[illegible]ect on lettuce growers in California [illegible]

[illegible] million to [illegible] million [illegible] price changes [illegible]

[illegible] to other crops.

[illegible] Impacts on Other Crops. The [illegible]

[illegible] production, acreage changes, and impacts on [illegible]

[illegible] because of three unknown factors. First, [illegible]

[illegible] efficiency on lettuce are available only for [illegible]

[illegible], no studies currently exist [illegible]

[illegible]table and related crops in the United States that there

[illegible]ice changes. Finally, a reliable estimate of the price

[illegible]ity of demand for lettuce vary from as low as -0.10 [illegible]

[illegible] in the U.S. is taken into account to a [illegible]

[illegible]fornia fall lettuce. 1/

[illegible] percent yield and quality loss estimated for the [illegible]

[illegible] the Alpha area amounts to about 4.2 million hundredweight

[illegible] 11 percent of total U.S. annual production. To maintain supply

[illegible]nal acreage would have to come into production. If this land were

[illegible]lar quality to the existing acreage, prices would have to increase

[illegible] and probably would need to be slightly higher

[illegible] competing crops.

[illegible] increase of 12 percent (from $8.00 to $9.00/cwt)

[illegible] are in the United States. [illegible]

[illegible]

total of about $50 million annually. In addition, other vegetable crop prices would increase slightly due to increased competition for land, further increasing the cost to consumers. On the other hand, agricultural landowners, especially lettuce growers who previously did not us pronamide, would benefit from increased returns to their resources. For example, a lettuce grower, who previously did not use pronamide, would experience no increase in costs and the $1.00 increase in price per hundredweight would amount to about $240 per acre per crop.

Summary of Short-Run Economic Losses and Their Incidence in Agriculture

If no price or acreage shifts occurred, prohibiting the use of pronamide on lettuce would reduce net revenues to lettuce growers by $25 to $37 million, primarily in California. Given the small acreage involved and, thus, the significance of this loss per acre, it is clear that shifts in acreage and/or price will occur. Too few agricultural economists, however, have given lettuce sufficient emphasis to predict whether, as a group, their returns will increase or decrease with the prohibition or pronamide.

Longer-Term Impacts. Since nearly all lettuce growers in California and other Southwest states who can benefit from the use of pronamide are using it, little or no growth in this use is predicted for the future in this area. To the extent that effective alternative herbicides or other weed management practices develop in the future, the importance of pronamide will decrease.

Chapter 5

HEALTH AND ENVIRONMENTAL INFORMATION

Characteristics[1/]. Pronamide is a solid, off-white, odorless product with a solubility in water at 25°C of 1.5×10^{-3} g/100g. To obtain herbicidal activity pronamide must move into the root zone of the weeds. Little activity is obtained from foliar contact alone. Pronamide is readily absorbed by plants through the root system, translocated upward and distributed into the entire plant. Translocation from leaf absorption is not appreciable.

In its mechanism of action, pronamide is a strong inhibitor of mitosis but may have additional effects. It is metabolized slowly by both tolerant and sensitive plants. The metabolites observed involve alterations of the aliphatic side chain.

Very little leaching of pronamide occurs in most soil types. Pronamide is readily adsorbed on organic matter and other colloidal exchange sites. Microbial action on pronamide in soil results in a moderate degree of conversion to the cyclized and subsequent hydrolysis products. Pronamide is inactive against common soil microorganisms.

Based on laboratory experiments, some loss of pronamide due to photo-decomposition may occur. Volatilization of pronamide under very hot and dry conditions has also been observed.

1/ Herbicide Handbook of the Weed Science Society of America, Third Edition, 1974, pp. 327-30.

Persistence of pronamide is variable (2 to 9 months) depending on soil texture and climatic conditions. Residual activity is greater in sandy soils with low organic matter. Accumulation from repeated annual applications to the same soil is not a problem.

Pronamide's general toxicological properties to farm animals, birds, wildlife, and fish include a relatively low order of toxicity. Acute oral toxicity - male rats, 8,350 mg/kg; female rats, 5,620 mg/kg; and mongrel dogs 10,000 mg/kg. Subacute toxicity: pronamide added to the diet of beagle dogs and rats at concentrations up to 4,050 ppm for a 3-month period had no effects on survival. Chronic toxicity: addition of pronamide to the diets of rats and beagle dogs in concentrations up to 300 ppm for 2 years showed no characteristic toxic effects. Acute dermal LD_{50} albino rabbits, > 3160 mg/kg. In one chronic feeding study male mice, but not female, produced an excess number of tumors (Pronamide: Position Document 1, Pronamide Working Group, EPA). Some toxicologists believe these data show that pronamide is a carcinogen, others do not.

Human Exposure. Most pronamide is applied to the soil after planting but before emergence of lettuce seedlings. Exposure of laborers and risk to them is minimal (see Appendix Document 11).

The most likely exposure of humans is by eating lettuce that was grown in California and Arizona where pronamide is used extensively in this crop. Lettuce samples taken by the Rohm and Haas Company in 1977 in the Salinas Valley area of California averaged less than 0.01 ppm pronamide residue and lettuce taken from fields treated with pronamide in the east coastal area of the U.S. averaged 0.06 ppm.

The second most likely exposure of humans is by eating blackberries, blueberries, boysenberries, and raspberries from plants that had been treated during the fall and winter with pronamide. There has been no measurable residue in such berries. This accounts for the nominal tolerance set at 0.05 ppm.

Established tolerance on alfalfa is 10 ppm. Alfalfa hay from alfalfa that had been treated with pronamide during the fall and winter would have residues less than 5 ppm. Alfalfa is not usually ingested directly by man. It is fed to dairy and meat animals and chickens. The residue tolerance set for eggs, meat, milk, and related products is 0.02 ppm (0.2 ppm for kidney and liver). This was based on feeding tests. In a market-basket survey in the areas of greatest use of pronamide in alfalfa, the Rohm and Haas Company has found no detectable residues of pronamide in milk.

Pronamide's use in non-food crops of turf, ornamentals, and Christmas trees presents very low exposure and risk to humans. The person operating the sprayer may be exposed to small amounts of spray drift infrequently while making the treatment once per year. Rain or irrigation water washes most of the pronamide from foliage of plants to the soil and thus reduces the hazard of exposure.

Environmental Considerations. Use of pronamide is such that there is minimal risk to vegetation in adjoining areas. Treatments are commonly applied to the soil by ground equipment. The herbicide does not affect plants by its vapors or small amounts of spray drift.

Data are not available on amounts of pronamide that might be carried in runoff water. But its low solubility limits it to being carried on the soil and organic particles of the soil to which it is adsorbed.

It presents low hazard to fish and wildlife because of their low exposure to pronamide and because of the low toxicity to animals and birds and moderately low toxicity to fish.

APPENDIX

Data from herbicide experiments in lettuce in California as an example of relative performance for weed control and responses of lettuce to treatment.

Table 1

The effect of herbicide treatment on the harvest of Great Lakes lettuce. (ML 6-70)

Treatment	lb/A	$\bar{X}$ % Harvest I	II	III	IV	$\bar{X}$
Kerb	1	93.8	88.5	87.5	92.6	90.6
Kerb	2	95.0	83.5	91.5	93.2	90.6
Kerb	4	91.3	92.0	80.0	91.2	88.9
Balan	1	56.8	77.3	79.6	95.0	80.1
Balan+Chemfoe	1+4	89.1	73.8	76.1	90.2	82.3
Chemfoe	4	86.8	85.8	84.5	88.7	81.2
Vegadex	6	97.7	72.7	78.0	95.6	86.0
Control	-	76.0	70.5	92.0	88.9	82.6

Date notes made: 8/25/69. Field Location: Spreckels in Monterey County.

Table 2

The effect of herbicide treatment on the weed control and yield of Great Lakes lettuce.

Treatment	lb/A	Weed* Control	Stand Count	Fresh Plot Weights	% Harvest 2 Dozen
Balan	1	84	44.1	221	84.3
Balan+ChemHoe	1+4	98	45.5	238	87.1
ChemHoe	4	62	41.3	201	70.2
Balan+Vegadex	1+4	81	42.1	220	80.9
Vegadex	4	55	40.1	194	61.1
Weeded Control	3 leaf	92	45.0	241	82.7
Weeded Control	6 leaf	90	40.3	196	61.1
Weeded Control	12 leaf	84	37.1	140	42.4
Non-weeded Control		0	37.5	137	18.6

*Major weeds: Purslane, hairy nightshade. Spreckels, CA.
Variety: R-200. June 1968.

Table 3

The effect of 4 preplant incorporated herbicides on Great Lakes lettuce at harvest.

Herbicide	lb/A	Thinning Wts. gm/plant	Average[1/] % Harvest	Head Wt.
Kerb	1	117	91	1.8
Kerb	2	116	86	1.9
Kerb	3	109	87	1.8
Kerb	4	101	85	1.8
Chemloe	6	114	91	1.7
Balan	1	112	90	1.7
Vegadex	6	116	86	1.9
Control (Hand weeded)	-	116	88	1.5

1/Average of   replications where 0 = no effect, 10 = complete weed control.

Table 4

The effect of 4 preplant incorporated herbicides on Great Lakes lettuce at harvest.

Herbicide	lb/A	Thinning Wt. gm/plant	Average[1/] % Harvest	Head Wt. lb/head
Balan	1	130	86	1.9
Balan	2	108	70	1.3
Kerb	1.5	131	85	1.9
Kerb	3	112	73	1.8
Chemhoe	4	129	85	1.8
Chemhoe	8	103	70	1.4
Vegadex	4	130	84	1.9
Vegadex	8	111	69	1.6
Control (Hand weeded)	-	131	84	1.8

1/Average of replications where 0 = no effect, 10 = complete weed control.

Table 5

A comparison of two methods of preplant applications on weed control and crop response. (A36-V9-27-1-74)

Treatment	lb/A	Method of Application	Average[1/] Weed Control	Average[1/] Crop Phyto.
Kerb	1.5	PPI	9.4	0.3
Kerb	3.0	PPI	9.1	1.0
Kerb	1.5	SA	9.7	0.0
Kerb	3.0	SA	9.7	0.3
Control (Hand Weeded)	-	--	2.3	0.0

1/Average of replications where 0 = no control and no effect on the lettuce and 10 = complete weed control and kill of lettuce.

Table 6

A comparison of Kerb and Balan applied preemergence for the control of two weed species and the effect on Great Lakes lettuce. (A36-V9-27-3-74)

		Average[1/] Weed Control		
Treatment	lb/A	Pigweed	Nightshade	Crop Phyto.
Kerb	1	7.1	9.0	0.25
Kerb	2	8.6	9.8	0.75
Kerb	3	8.0	9.1	0
Kerb	4	9.6	9.9	0.25
Balan	1	9.4	5.4	7.0
Balan	2	9.4	5.8	9.25

1/Average of replications where 0 = no weed control and no effect of lettuce, 10 = complete control of weeds and kill of lettuce.

Table 7

Summary average weed control in lettuce trials by species. 1968-1976.

Herbicide	lb/A	Common Nettle	Shepherds purse	Hairy nightshade	Nettleleaf goosefoot	Henbit	Purslane	Pigweed	Mustard
Vegadex	4-6	89	59	63	86	87	82	75	50
ChemHoe	4-8	99	70	98	88	94	62	72	53
Furloe	3	100	80	91	96	88	62	80	66
Dacthal	6	63	59	9	95	89	86	63	57
Dacthal	12	88	70	62	97	--	88	90	57
Prefar	6	70	38	16	88	68	80	85	40
Prefar	12	88	--	30	95	--	95	95	48
Balan	1	78	70	65	99	99	95	85	46
Balan	2	90	75	80	100	--	98	95	55
Kerb	1	98	99	100	90	81	100	75	97
Kerb	2	100	100	100	95	85	100	80	99
Kerb	3	100	100	100	100	90	100	90	100

Table 8

Summary of five preemergence lettuce trials under furrow and sprinkler irrigation.

		Average Percent[a] Weed Control by Specie										
Treatment	lb/A	Shepherd's purse	Purslane	Neetleleaf goosefoot	Sowthistle	Burning Nettle	Lambs-quarter	Hairy Nightshade	Pigweed	Groundsel	Malva	Knotweed
Kerb	1/2	94	98	58	16	90	52	100	--	20	--	100
Kerb	1	97	100	70	33	95	61	100	67	30	66	100
Kerb	2	98	100	92	33	95	90	100	75	0	85	100
Kerb	4	100	100	98	--	95	97	--	100	--	100	---
Balan	1	12	77	25	16	65	35	0	33	4	65	80
Balan+Chemlloe	1+4	66	100	50	33	100	52	100	42	--	68	---
Chemlloe	4	56	69	22	33	95	20	76	14	3	53	100
Vegadex	6	77	--[b]	58	33	41	64	55	80	--	65	16
Balan+Kerb	1+1	100	--	97	0	--	98	100	--	--	--	100

a = Obtained from weed counts of treatments and control.
b = Weed species not present at this trial.

Table 9

The effect of herbicides on the degree of weed control and the remaining weed species in Monterey Co. (ML 6-69)

Treatment	lb/A	Weed Control I	II	III	IV	Ave.
Kerb	1	SP 7	SP 5	SN 9	9	7.5
Kerb	2	ST 9	HB 9	HB 9	10	9.8
Kerb	4	HB&M 9	10	ST 9	9	9.3
Balan	1	SP 4	SP&SN 0	SN 0	SN 0	1.0
Balan+Chemloe	1+4	M 8	SP 5	SP 7	SN&ST 9	7.0
Chemloe	4	SP 0	HB 9	HB&SP 9	SP 0	4.5
Vegadex	6	SN 7	SN 8	SN 0	SN&SP 4	4.8
Control	-	SN 5	SP&SN 0	SN 4	SN 4	3.3

Major weeds: SP = Shepherd's purse; SN = Stinging nettle; HB = Henbit; ST = Sowthistle; M = Mustard.

Date Notes Made: 7/21/69. Spreckels. Preemergence.

Table 10

The effect of herbicide treatment on the cost of removing weeds by hand hoeing.

Treatment	lb/A	Weed Control*	Man Hrs/Ac
Kerb	1	95%	8.1
Kerb	2	98%	7.8
Balan	1	77%	10.5
Vegadex	4	70%	11.1
ChemHoe	4	64%	12.9
Control (weeded)	-	96%	18.4
Weedy Control	-	0%	

*Major weeds: Shepherd's purse, shortpod mustard, hairy nightshade, pigweed, purslane, burning nettle, common groundsel.

**Lettuce weeded at the 3-4 leaf stage.
Spreckels, CA, April 1970.

Document 11

OFFICE BOX 1817
S, CALIFORNIA 93901

SOILSERV, INC.

PLANT: TELEPHONE 422-6473
1427 ABBOTT STREET

August 5, 1977

Dr. Dayton Klingman
Pronamid Assessment Team
ARS USDA
Baltsville, Md. 20705

Gentlemen:

We are a major commercial applicator of agricultural chemicals in the central coast section of California. Lettuce is one of the principal crops of the area, production involving approximately 60,000 acres annually. Our firm applies Rohm & Haas Kerb to about 50% of this acreage. Use of the product has increased rapidly since its registration, and certain segments of our work force have had significant exposure during application periods. Lettuce planting begins in December and ends the first week of August. Employee exposure occurs during this period.

In our overall safety program, we provide our employees with all required clothing and equipment necessary for compliance to laws and regulations in the state of California. Additionally, we retain a physician who oversees our company's medical policy, which includes preemployment physicals, monitoring cholinesterase inhibition in those employees exposed to the organic phosphates and carbamates, and treating work-related accidents and illnesses. To our knowledge, the employees involved with Kerb have not had any physical problems due to contact with this compound.

Very truly yours,

SOILSERV, INC.

E.D. Bedolla, Jr.
Vice-President

EDB/1c

June 28, 1977

MEMORANDUM

TO: A. D. Worsham

FROM: M. A. Cohen

SUBJECT: RPAr for Pronamide

Enclosed is the information which you requested on the use of pronamide (Kerb) on ornamentals and Christmas trees. This information should stress the importance that Kerb is essential for our $25 million dollar industry in North Carolina.

Ib Recommended for use on specific ornamentals, and Christmas trees. Apply to annual and perennial grasses. Rate 1-4 lb active ingredient/acre.

Ic Pest infestation is located throughout North Carolina but especially heavy in Western North Carolina.

Id Pest is distributed heavily from Northwest through Western portion of North Carolina and moderately heavy in Piedmont secction of North Carolina..

Ie Approximately 2000 acres treated at 1-4 lbs Ai. Method of application - pre-emergence.

If 50 WP

Ig No other alternative pesticide to be used for control of quackgrass and orchardgrass on ornamental commodity.

IIa Enclosed is data on test showing control of chemical versus untreated plots.

IIf For last three years no phytotoxicity noted on any plant species treated.

IIId At present there is no alternative chemical for control of perennial grasses. No practical cultural treatment due to the rough terrain.

IVa No detrimental effects have been reported during a three-year period on either wildlife, aquatic species or pesticide applicators.

MAC:mp
Enclosures

Weed Control in Christmas Trees

Fraser Fir

ctive: To evaluate the effectiveness of several winter herbicides applied singly or in combination for control of fescue, quackgrass and wild strawberry in *Abies fraseri*. Another objective was to evaluate formulation differences, as well as compare a split-type application (pronamide applied on February 26 followed by simazine on May 5) to a tank mix combination of pronamide and simazine applied in February.

hod:

Location - Haywood County

Plot Size - 8 feet by 60 feet

Plant Species - *Abies fraseri* (Fraser Fir)

Experimental Design - Randomized complete block design, two replications

Soil Composition - pH: 6.0, %OM: 4.0

Treatment Date - Preemergence: February 26
May 5

Rated - June 21, 1976

Environmental Data -

Status of weeds	Established	
Status of crop	Established (10-15")	
	February	May
Wind Velocity	10 mph	0-5 mph
Soil Moisture	moist	moist
Temperature		
Air	42 F	68 F
Soil surface	44 F	66 F
Soil @ 2"	40 F	59 F
Soil @ 6"	42 F	50 F

1. Effect of several herbicides applied singly or in combination on weed control in Abies fraseri (Haywood County).

ment ber	Treatment	Rate and Method	Form	% Control: Fescue	% Control: Wild Strawberry	% Control: Quackgrass
	Pronamide	3.0 P	4 G	0	0	0
	Pronamide	3.0 P	50 WP	95	0	82
	Simazine	4.0 P	4 G	0	0	0
	Pronamide[1] Simazine	3.0 P 1.5 P	50 WP 80 WP	97	87	87
	Pronamide[1] Simazine	3.0 P 3.0 P	50 WP 80 WP	100	100	97
6	Pronamide[2] Simazine	3.0 P 4.0 P	50 WP 80 WP	100	100	97
7	Control			0	0	0
LSD .05				6	16	4

[1] Split application--pronamide applied on February 26, simazine applied on May 5
[2] Tank mix combination--pronamide and simazine applied on May 5

RESULTS

Results of this study indicate that combination treatments of pronamide and simazine were significantly more effective for control of fescue, wild strawberry and quackgrass (except pronamide @ 3.0 lbs. WP on fescue) than singly applied treatments. Data on application rates for combination treatments showed no significant difference in control of fescue or wild strawberry, but did with quackgrass.

Data on differences in formulations between pronamide WP and granules indicate significantly better control with a WP formulation. It should be noted that no rainfall occurred for approximately 4 weeks after application and could be the limiting factor for poor control with pronamide and simazine granules.

Results of a split application of pronamide and simazine versus a combination tank mix generally indicate that there was no difference between pronamide @ 3.0 lbs. WP and simazine @ 3.0 WP (split application) versus pronamide @ 3.0 lbs. WP and simazine @ 4.0 lbs WP (tank mix) for control of quackgrass, wild strawberry and fescue. No phytotoxicity was noted with any chemical, rate, or combination in this study.

Document 13

Weed Control in Christmas Trees

Fraser Fir

ctive: To evaluate the effectiveness of several winter herbicides applied singly or in combination for control of quackgrass, bracken fern, and fescue in _Abies fraseri_. Another objective was to determine if a split-type application (pronamide applied on March 3 followed by simazine on May 4) was more effective than a tank mix combination (pronamide applied with simazine on May 4).

od:

Location - Macon County

Plot Size - 3½ feet by 15 feet

Plant Species - _Abies fraseri_ (Fraser Fir)

Experimental Design - Randomized complete block design, two replications

Soil Composition - pH: 6.0, % OM: 2.7

Treatment Date - Preemergence: March 3
May 4

Rated - June 24, 1976

Environmental Data -

Status of weeds	Established	
Status of crop	Established	
	March 3	_May 4_
Wind velocity	0-5 mph	0-5 mph
Soil moisture	moist	moist
Temperature		
Air	30 F	49 F
Soil surface	32 F	52 F
Soil @ 2"	34 F	43 F
Soil @ 6"	35 F	45 F

. Effect of several herbicides applied singly or in combination on weed control in <u>Pinus strobus</u> (Macon County).

ent	Treatment	Rate and Method	Form	% Control: Quackgrass	% Control: Bracken Fern
	Pronamide	3.0 P	4 G	95	30
	Simazine	4.0 P	4 G	45	30
	Pronamide[1] Simazine	3.0 P 1.5 P	50 WP 80 WP	100	30
	Pronamide[1] Simazine	3.0 P 3.0 P	50 WP 80 WP	100	30
	Pronamide[2] Simazine	3.0 P 4.0 P	50 WP 80 WP	100	30
	Control			0	15
.05				1	22

plit application--pronamide applied on February 26; simazine on May 4
ank mix combination--pronamide and simazine applied on February 26

RESULTS

Results from this study suggest that all treatments gave acceptable control of ckgrass except simazine at 4.0 lbs., while all treatments were ineffective on acken fern.

Data on combination treatments indicate that pronamide and simazine applied ngly gave no better weed control than a tank mix combination of these two products. All chemicals and rates in this study showed no phytotoxicity to fraser fir.

APPENDIX

Document 14

WEED CONTROL IN CHRISTMAS TREES

Fraser Fir

ve: To determine the effect of date, chemical, and rate on quackgrass control in *Abies fraseri*.

ocation - Avery County

lot Size - 3½ feet by 16 feet

lant Species - *Abies fraseri* (Fraser Fir)

Experimental Design - Randomized complete block, three replications

Soil Composition - pH: 5.8, % O.M.: 3.0

Treatment Date - Preemergence: February 3, March 4, and April 11, 1975

Rated - May 27, 1975

Environmental Data -

Status of weeds	Established		
Status of crop	Established, 3' - 4'		
	February	March	April
Wind Velocity	0-5 mph.	0-5 mph.	5-10 mph.
Precipitation	moist	moist	dry
Temperature			
Air	30° F	38° F	56° F
Soil Surface	30° F	36° F	54° F
Soil @ 2"	40° F	30° F	46° F
Soil @ 6"	40° F	32° F	42° F

Effect of herbicides and date of application on weed control in *Abies fraseri* (Avery County).

Treatment	Rate and Method	Form	% Control - Grass February 3	March 4	April 11	Phyto-toxicity
Pronamide	2 P	50 WP	60	93	90	10
Pronamide	4 P	50 WP	96	100	98	10
Simazine	2 P	80 WP	53	53	76	10
Simazine	4 P	80 WP	56	63	0	10
Check			0	0	0	10

05 - 36.0

minant weed: Quackgrass

RESULTS

Results indicated that pronamide at 4.0 lb. rate was slightly more effective than 2.0 lbs., and that both rates of pronamide were better than simazine. The data also indicated that time of application within rates for both chemicals showed no significant difference. No visual injury was noted. Best overall treatment and date was pronamide at 4.0 lbs. on March 4.

APPENDIX

Document 15

WEED CONTROL IN CHRISTMAS TREES

White Pine

ctive: To determine the effectiveness of several herbicides applied singly or in combination on weed control and safety on Pinus strobus.

od:

Location - Jackson County

Plot Size - 3½ feet by 16 feet

Plant Species - Pinus Strobus (White Pine)

Experimental Design - Randomized complete block, three replications

Soil Composition - pH: 5.5, % O.M.: 1.4

Treatment Date - February 19, 1975

Rated - June 2, 1975

Environmental Data -

Status of weeds	Established
Status of crop	Established
Wind Velocity	10-15 mph.
Precipitation	Wet
Temperature	
Air	58° F
Soil Surface	56° F
Soil @ 2"	52° F
Soil @ 6"	34° F

ct of herbicides on weed control in Pinus strobus (Jackson County)

Treatment	Rate and Method	Form	% Control Grass	Phytoxicity
Pronamide	2.0 P	50 WP	56	10
Pronamide	4.0 P	50 WP	90	10
Simazine	2.0 P	80 WP	53	10
Simazine	4.0 P	80 WP	60	10
Pronamide Simazine	2.0 P 2.0 P	50 WP 80 WP	62	10
Pronamide Simazine	4.0 P 2.0 P	50 WP 80 WP	98	10
Perfluidone	6.0 P	50 WP	00	10
Perfluidone	8.0 P	50 WP	00	10
Pronamide Perfluidone	2.0 P 6.0 P	50 WP 50 WP	77	10
Pronamide Perfluidone	4.0 P 8.0 P	50 WP 50 WP	98	10
Control			00	10

12.9

nt weed: Orchardgrass

RESULTS

Results from Table 6 indicate that pronamide at 4.0 lbs. was more effective 2.0 lbs. in controlling orchardgrass. Simazine nor perfluidone gave accept- weed control when applied singly. Combinations of pronamide at 4.0 lbs. plus azine at 2.0 lbs., and pronamide at 4.0 lbs. plus perfluidone at 8.0 lbs. gave t control. No visual injury was noted with any chemical or rate.

APPENDIX

Document 16

WEED CONTROL IN CHRISTMAS TREES

Fraser Fir

ve: To evaluate the effectiveness of several herbicides on weed control in *Abies fraseri*.

ocation - Jackson County

ot Size - 3½ feet by 25 feet

lant Species - *Abies fraseri* (Fraser Fir)

xperimental Design - Randomized complete block, three replications

oil Composition - pH: 5.5, % O.M.: 6.0

reatment Date - Preemergence: February 19, 1975
Postemergence: April 10, 1975

Rated - June 2, 1975

Environmental Data -

Status of weeds	Established	
Status of crop	Established	
	February	April
Wind Velocity	0 - 5 mph.	0 - 5 mph.
Precipitation	wet	moist
Temperature		
Air	42° F	60° F
Soil Surface	48° F	60° F
Soil @ 2"	52° F	42° F
Soil @ 6"	34° F	44° F

ect of herbicides on weed control in *Abies fraseri* (Jackson County)

Treatment	Rate and Method	Form	% Control Orchard-grass	Quack-grass	Briars	Phyto-toxicity
Pronamide	2.0 P	50 WP	65	60	00	10
Pronamide	4.0 P	50 WP	95	100	00	10
Simazine	2.0 P	80 WP	00	00	00	10
Simazine	4.0 P	80 WP	40	40	00	10
Glyphosate	1.0 PE	3 lbs/gal.	90	95	30	10
Glyphosate	2.0 PE	3 lbs/gal.	100	100	100	10
Pronamide Simazine	2.0 P 2.0 P	50 WP 80 WP	85	85	00	10
Pronamide Simazine	4.0 P 2.0 P	50 WP 80 WP	100	100	00	10
Pronamide Glyphosate	2.0 P 1.0 PE	50 WP 3 lbs/gal.	90	90	40	10
Pronamide Glyphosate	4.0 P 1.0 PE	50 WP 3 lbs/gal.	100	100	45	10
Simazine Glyphosate	2.0 P 1.0 PE	80 WP 3 lbs/gal.	95	95	50	10
Simazine Glyphosate	2.0 P 2.0 PE	80 WP 3 lbs/gal.	100	100	100	10
Control			00	00	00	10

RESULTS

Data from Table 5 indicate that both pronamide and glyphosate gave excellent control of orchardgrass and quackgrass. Combination treatments of pronamide plus simazine at lower rates also gave acceptable control, but treatments of simazine by itself were found unacceptable. Results on briar control indicated that the 2.0 lbs. rate of glyphosate gave excellent control of briars and prevented any regrowth. Applications of glyphosate in this study were applied as basal treatments rather than over the tops of trees.

REVIEW OF THE IMPORTANCE OF PRONAMIDE TO WISCONSIN AGRICULTURE

R. G. Harvey, J. D. Doll, and R. E. Doersch[1/]

It is widely recognized that Wisconsin is the leading producer of dairy oducts in the United States with some 49,000 dairy farms producing over .3 billion pounds of milk in 1976. It is not always appreciated, however, hat the basis of this tremendous dairy industry is the large acreage devoted o the production of legume forages to feed the dairy cows. Wisconsin leads he nation in acreage of legume forages with over 3 million acres of alfalfa nd another 1 million acres of red clover, trefoil, and other forage legume species. Weeds can be a serious problem in these fields, and the most serious weed in Wisconsin is quackgrass. Quackgrass infests essentially every field in the state and has an economical impact in most of them. At the present time, few herbicides are available for controlling quackgrass. Atrazine or simazine are available in corn but leave residues which can injure rotation crops. In northern areas of the state, where a short growing season limits corn production, these chemicals cannot be used effectively. Glyphosate is available for use prior to field corn, sweet corn, soybeans, oats, wheat, barley, or sorghum but not prior to the legume forages. Dalapon is available for use prior to corn, field beans, kidney beans, lima beans, snap beans, or potatoes but not prior to the forage legumes. Experience has shown it to provide less than satisfactory control when it is used. EPTC plus R-25788 (Eradicane) is registered for use on corn, but lasting control has not usually resulted from its use. Pronamide is presently registered for use in alfalfa and other legume forages

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d has performed exceptionally well in seven years of testing and in farmer .e. The EPA has issued a Rebuttable Presumption Against Registration (RPAR) jainst this product. It is for the purpose of demonstrating the need and sefulness of pronamide in Wisconsin that this review was prepared.

In most crops weed growth is separated from the crop at harvest time, nd the primary losses they cause are related to yield reductions. In forage rops weeds cannot be separated from the harvested crop and actually contribute o the total dry matter production. Losses are more closely associated with reductions in forage quality, nutrition, palatability and digestibility, stand longevity, and with increased problems in rotation crops[6]. Palatability and digestibility are particularly important since animal scientists estimate that only one third of the value of a forage is associated with its nutritional content, while two thirds is associated with how readily animals consume and digest it[1].

Traditionally, many dairy farmers seed a grass along with their legume forage. Grass helps prevent bloat in cattle grazing legume pastures, aids in curing hay, fills in areas where legumes are lost from winterkill, and helps prevent soil erosion. Quackgrass provides a natural source of grass in many legume forage fields in the northern states. When well managed, the nutritional value of quackgrass is similar to that of orchardgrass, bromegrass, or timothy[7]. The quackgrass is more competitive, however, and reduces the legume vigor. It also yields less than the other grass species. All grass species, including quackgrass, produce forage lower in protein content and usually less palatable to livestock than legumes such as alfalfa, red clover, or trefoil. Research conducted over the past 7 years at the University of Wisconsin has demonstrated that controlling quackgrass can improve overall quality and profitability of legume forages.

Most of the research dealing with quackgrass control in legume forages as involved the herbicide pronamide. Many of the principles established ould be related to other herbicides as well. In a comparison of 122 herbicides nder greenhouse conditions, pronamide was the most effective in inhibiting evelopment of quackgrass rhizome buds(4). In the field, while pronamide injures or slows development of quackgrass and other perennial grass species, it seldom totally eradicates the infestation(5). But this slight delay in quackgrass growth allows legume forages to establish a competitive advantage. The lack of total eradication may actually be desirable in alfalfa since if the legume winter-kills, quackgrass quickly returns to prevent erosion and to provide emergency forage.

In alfalfa pronamide applications are beneficial in several ways. Since quackgrass typically is lower in protein than alfalfa, pronamide applications usually increase crude protein content of harvested alfalfa forage by 4 to 6 percent(1). Yields are not normally affected, but some studies suggest that pronamide applications may actually increase longevity of alfalfa stands(3). Feeding tests conducted at the University of Wisconsin using goats as a typical ruminant species demonstrated that an application of 1.5 pounds per acre of pronamide increased the average dry matter consumed by 30%, crude protein content by 39%, digestibility of dry matter by 11%, and digestibility of crude protein by 15%. In total this resulted in an increase of 44% in digestible dry matter consumed and of 108% in digestible crude protein consumed(1).

Theoretically, these changes should result in greater milk or meat production if they also occurred in cattle. Feeding trials were recently completed at the University of Wisconsin Ashland Experimental Station to determine the affects of pronamide on milk production in dairy cattle.

Half of a quackgrass infested alfalfa field was treated with 1.0 pound per acre of pronamide in October 1975. The remainder of the field was left untreated. While the quackgrass infestation was severe, it was typical of fields throughout Wisconsin and the rest of the northern US. The first cutting hay was harvested from both the pronamide-treated and the untreated area in June of 1976. Forage analysis indicated that hay from the area treated with pronamide contained 16.8% crude protein while hay from the untreated area had only 13.2% crude protein.

Ten holstein cows were grouped into five uniform pairs. One of each pair was fed hay from the pronamide-treated area while the other was fed hay from the untreated area. Total feed consumption, milk production, and animal weight were monitored over a four-week period.

The cows fed hay from the pronamide-treated area produced an average of 507 pounds of milk per week while cows fed hay from the untreated area produced only 425 pounds per week. This represented a 19% increase in milk production as a result of pronamide use. Butter-fat content was 3.62% from both groups. Cows fed the treated forage also consumed 9% more hay. Because of the higher crude protein content of the treated forage and the greater consumption of this forage, cattle being fed the treated forage received 39% more crude protein from the hay than those fed the untreated forage. For this reason the cows receiving pronamide-treated hay were fed 9% less crude protein in their concentrate. Their concentrate ration was adjusted to contain only 14% crude protein while cows fed hay from the untreated area received concentrate with 19% crude protein.

Using average forage yields from Wisconsin field trials over a seven-year period and average milk and feed prices compiled by the Wisconsin Department of Agriculture for 1976, the researchers estimate that an investment of $15

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searchers estimate that an investment of

an application of 1.0 pound of pronamide per acre could result in a return $71 per acre. The return would be in increased milk production and reduced ;t for grain and protein supplement. The cost estimates do not include the st of applying the herbicide. Likewise the benefits don't consider the creased longevity of alfalfa stands with the reduced quackgrass competition the value of diminished quackgrass infestation to later rotational crops.

Field studies have shown that the removal of quackgrass with pronamide may ctually reduce average whole-season forage yields. But the feeding value of he treated forage is improved. In 17 tests untreated plots yielded an average of 4.10 tons per acre of hay at 12% moisture while pronamide-treated plots yielded 3.97 tons per acre. While not statistically significant, these differences are relatively consistent. The major yield reduction occurred in the first cutting where the rapid early growth of quackgrass helped the un-treated plots yield an average of 2.33 tons per acre while the pronamide-treated plots yielded only 2.04 tons per acre. The pronamide-treated plots actually yielded more than the untreated plots in the second and third cuttings. During this period the quackgrass tends to become dormant. Also, moisture conserved by quackgrass control in the first cutting might have been available for greater alfalfa growth in the later cuttings. Average crude protein content of the first cutting was 18.8% for the pronamide-treated hay and only 14.8% in the hay from untreated plots. No differences were observed in second or third cutting hay where protein content averaged 21% both with and without pronamide.

Some dairy farmers have speculated that removing quackgrass with pronamide might increase the hazard of winter injury to the alfalfa. Trials conducted since 1970 throughout Wisconsin show no evidence of such a problem.

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n fact, quackgrass control significantly increased the survival of alfalfa in ne trial. Such might be expected under conditions of low potassium fertility here potassium uptake by quackgrass might reduce its availability to the alfalfa. Adequate potassium fertilization is essential for the winter-hardiness of alfalfa. The use of pronamide should not be expected to substitute for good soil fertility. One limitation to widespread use of pronamide is that it must be applied in the fall after soil temperatures drop below $60^{o}F$[8]. Pronamide breaks down too rapidly at higher soil temperatures. Since spring is our normal herbicide application season, many growers are reluctant to get their sprayer out again in fall. Last year the Wisconsin Department of Agriculture issued a state label allowing pronamide to be impregnated on soil fertilizer. Tests have shown pronamide to work equally well when applied on fertilizer or in water. Since alfalfa should be top-dressed anyway to maximize production and improve winter-hardiness, both programs can be combined into one efficient operation. And most importantly the pronamide can be applied without getting the sprayer out again.

Pronamide will not cause alfalfa or other non-spreading legumes to grow where plants were not growing before. For best results pronamide should only be applied to fields in which sufficient alfalfa remains to cover areas vacated by grass removal. Otherwise yields may be significantly reduced and tolerant weeds will quickly invade the areas vacated by the grasses that were controlled with pronamide.

Several other herbicides have also been investigated for quackgrass control in alfalfa. Simazine is registered for use in alfalfa but only slightly suppresses quackgrass growth. Terbacil is registered and is effective, but label restrictions prevent the planting of other crops on treated fields for

two years following application. In northern states winterkill may occasionally require replanting after a shorter waiting period, thus, use is discouraged. Experimentally, metribuzin has demonstrated excellent control of broadleaf weeds but only moderate suppression of quackgrass. Registration is likely in the future. Buthidazole (Vel-5026) has controlled many weeds including quackgrass in alfalfa, but more research is required to assure adequate crop tolerance.

Glyphosate readily controls quackgrass when applied prior to planting many crops. Results obtained to date indicate that applications prior to planting alfalfa will reduce quackgrass problems. In tests conducted at Arlington, Wisconsin; however, reinfestation of alfalfa plots with quackgrass following a glyphosate application was much more rapid than in adjacent corn plots. Only two years after an application of 1.5 lb/A of glyphosate, 97% control persisted in corn while only 44% remained in alfalfa. Perhaps follow-up applications with pronamide may be useful.

For the present at least, pronamide is definitely the product of choice for controlling quackgrass in alfalfa and other forage legumes. NO EFFECTIVE SUBSTITUTES ARE AVAILABLE. Realistically, usage of pronamide for weed control in Wisconsin forages has been low but has increased steadily, and the need and benefits are great. Accurate figures on the amount used, however, would only be available from the manufacturer. If used on only 10% of our forage crop, use of pronamide could result in a net return of at least 22 million dollars to Wisconsin dairy farmers. An even greater acreage needs treatment and might be treated in the future. Consequently, we believe that maintaining the registration of pronamide for use in Wisconsin is of extreme importance. We would be willing to assist in any way possible to collect data or conduct research needed to support this registration.

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